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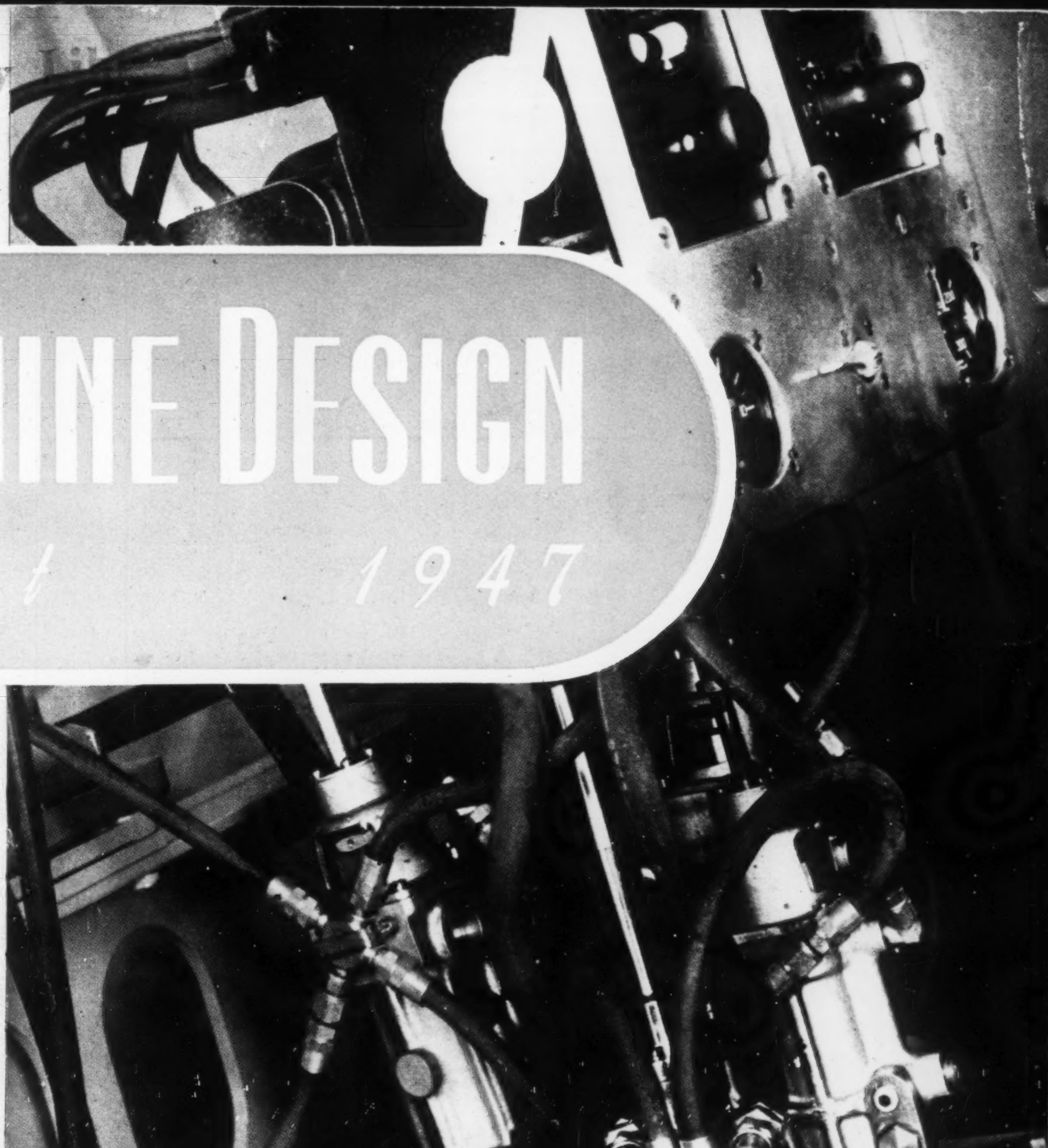
Wichita City Li

MACHINE DESIGN

August 1947



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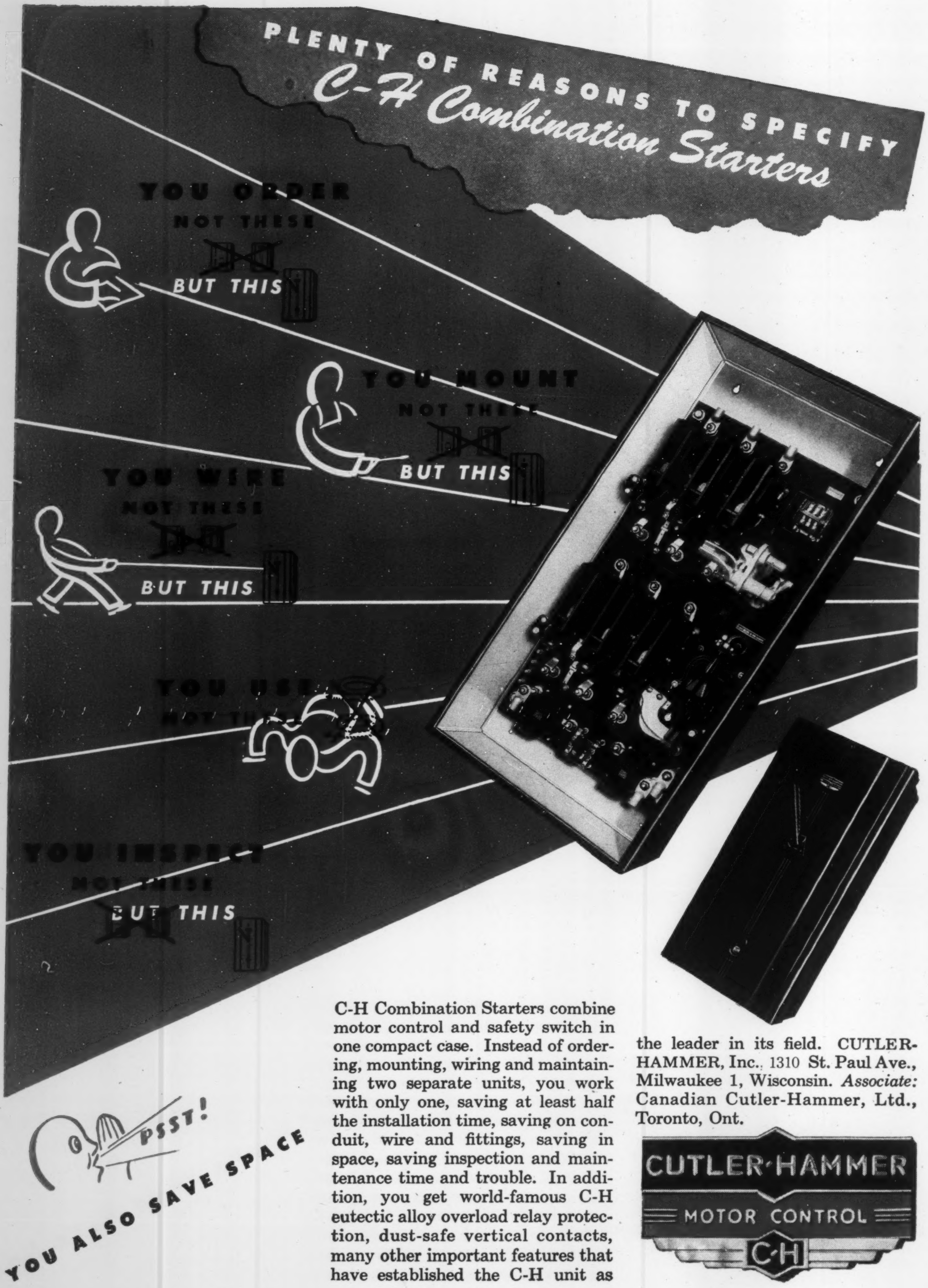
TRENDS IN STYLING . . . PANCAKE MOTOR

PLENTY OF REASONS TO SPECIFY *C-H Combination Starters*


YOU ORDER
NOT THESE
BUT THIS
YOU MOUNT
NOT THESE
BUT THIS
YOU WIRE
NOT THESE
BUT THIS
YOU USE
NOT THESE
YOU INSPECT
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BUT THIS
PSST!
YOU ALSO SAVE SPACE

C-H Combination Starters combine motor control and safety switch in one compact case. Instead of ordering, mounting, wiring and maintaining two separate units, you work with only one, saving at least half the installation time, saving on conduit, wire and fittings, saving in space, saving inspection and maintenance time and trouble. In addition, you get world-famous C-H eutectic alloy overload relay protection, dust-safe vertical contacts, many other important features that have established the C-H unit as the leader in its field. CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

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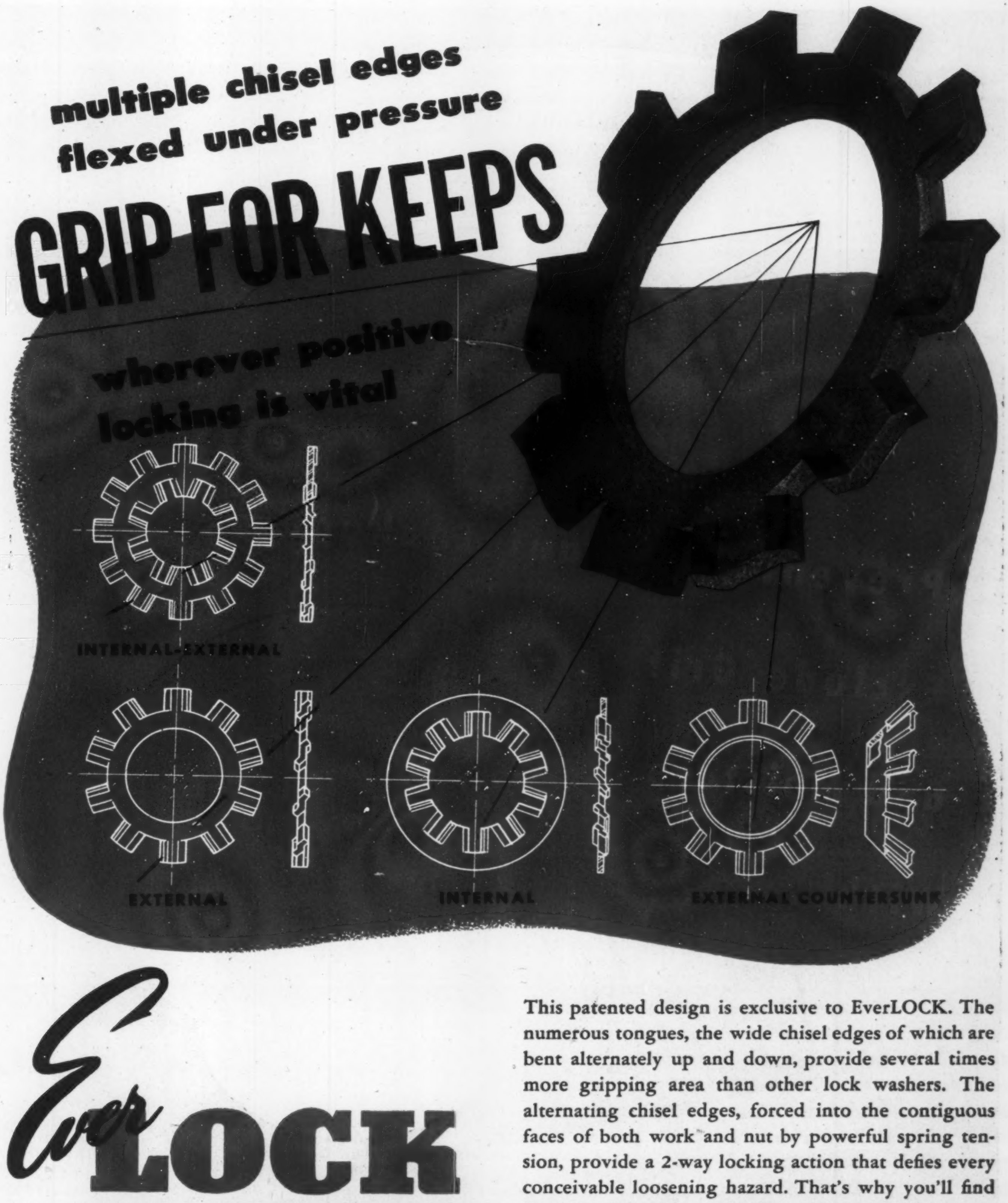
MOTOR CONTROL
C-H


multiple chisel edges
flexed under pressure
GRIP FOR KEEPS
wherever positive
locking is vital
INTERNAL-EXTERNAL
EXTERNAL
INTERNAL
EXTERNAL COUNTERSUNK

EverLOCK WASHERS
THE WASHER THAT HAS THE EDGE

This patented design is exclusive to EverLOCK. The numerous tongues, the wide chisel edges of which are bent alternately up and down, provide several times more gripping area than other lock washers. The alternating chisel edges, forced into the contiguous faces of both work and nut by powerful spring tension, provide a 2-way locking action that defies every conceivable loosening hazard. That's why you'll find EverLOCK washers guarding vital assemblies on so much heavy machinery, electrical appliances, automotive and aviation equipment.

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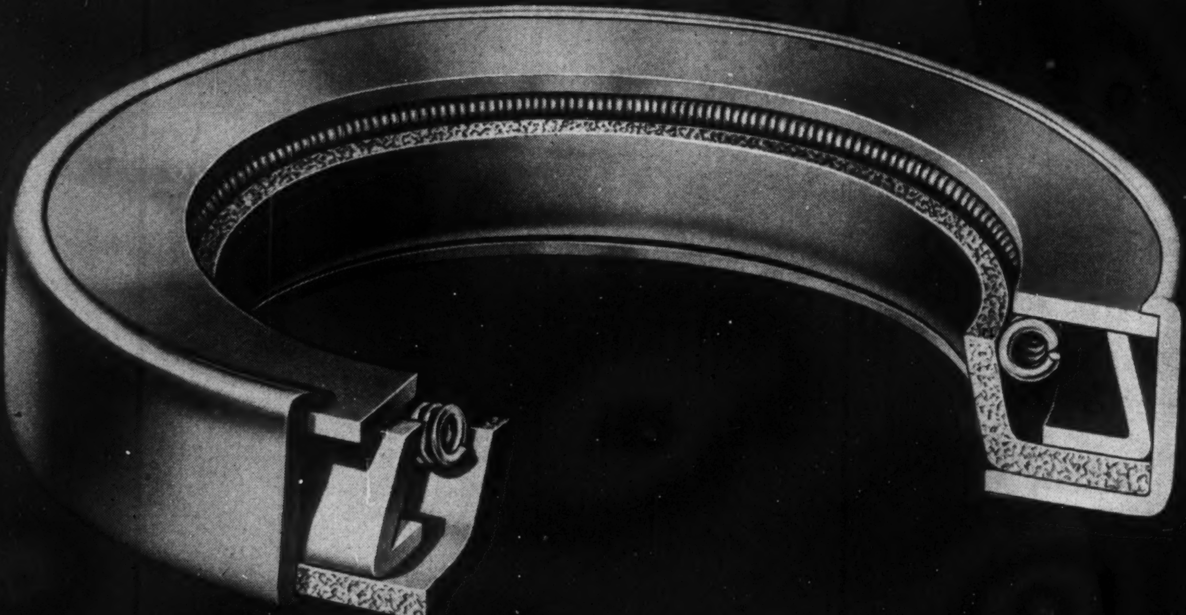

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Published by The Penton Publishing Co. E. L. Shaner, Pres. and Treas.; G. O. Hays, Vice Pres. and Gen. Mgr.; R. C. Jaenke, Vice Pres.; F. G. Steinebach, Vice Pres. and Secy.; E. L. Werner, Asst. Treas. Published on the seventh of each month.

MACHINE DESIGN
August 1947

This Month's Cover: Test stand for checking performance of Sperry gyropilots, simulating flight conditions. Pressures in the system run up to 200 psi, pulsating at rate of 12 times per minute. Oil flow varies between 1.8 and 3 gpm.—photo, courtesy Restoflex Corp.

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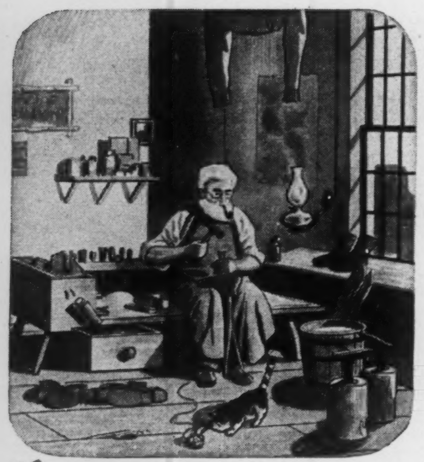
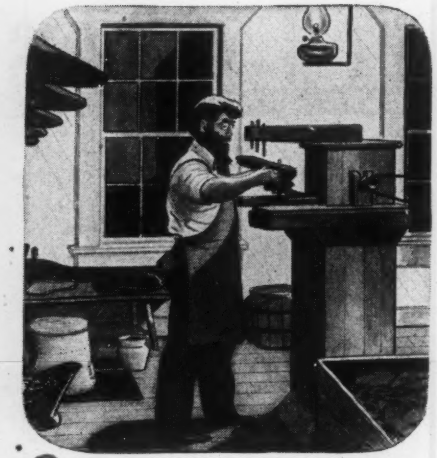
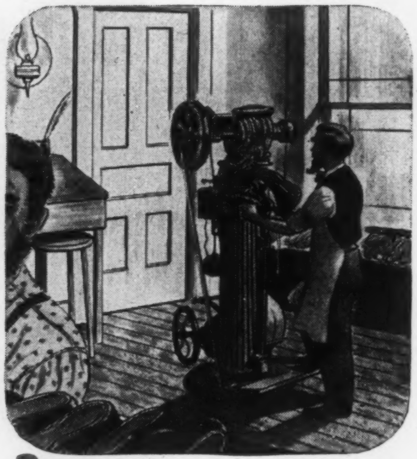


1 **1851**—John Nichols, a Lynn Shoemaker, adapted the Howe sewing machine to sew the uppers of shoes, doing away with the slow process of hand sewing. This started a fever of invention and innovation in the shoe industry in America that has carried to the present day.

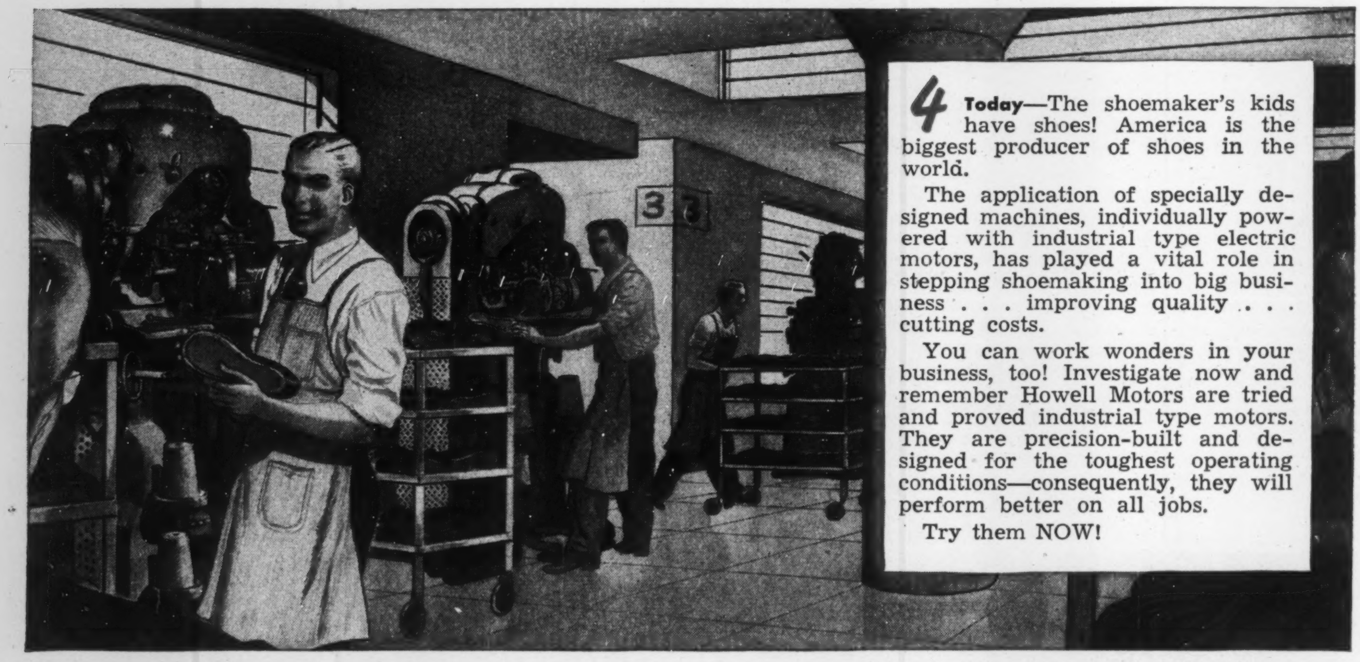


2 **1858**—Lyman R. Blake, of South Abington, Mass., invented a machine to sew soles to uppers. This was subsequently improved by Robert Mathies and manufactured by Gordon McKay. It became famous as the McKay sewing machine . . . set the stage for more progress.



3 **1862**—Goodyear Welt Machine ushered in the third stage. In 1890, electric motors arrived. By 1915—Howell began specializing in industrial type motors. Soon, Howell Red Band Motors, specially designed for application in this and other industries, made their appearance.

Three stages to big business in shoes!



4 **Today**—The shoemaker's kids have shoes! America is the biggest producer of shoes in the world.

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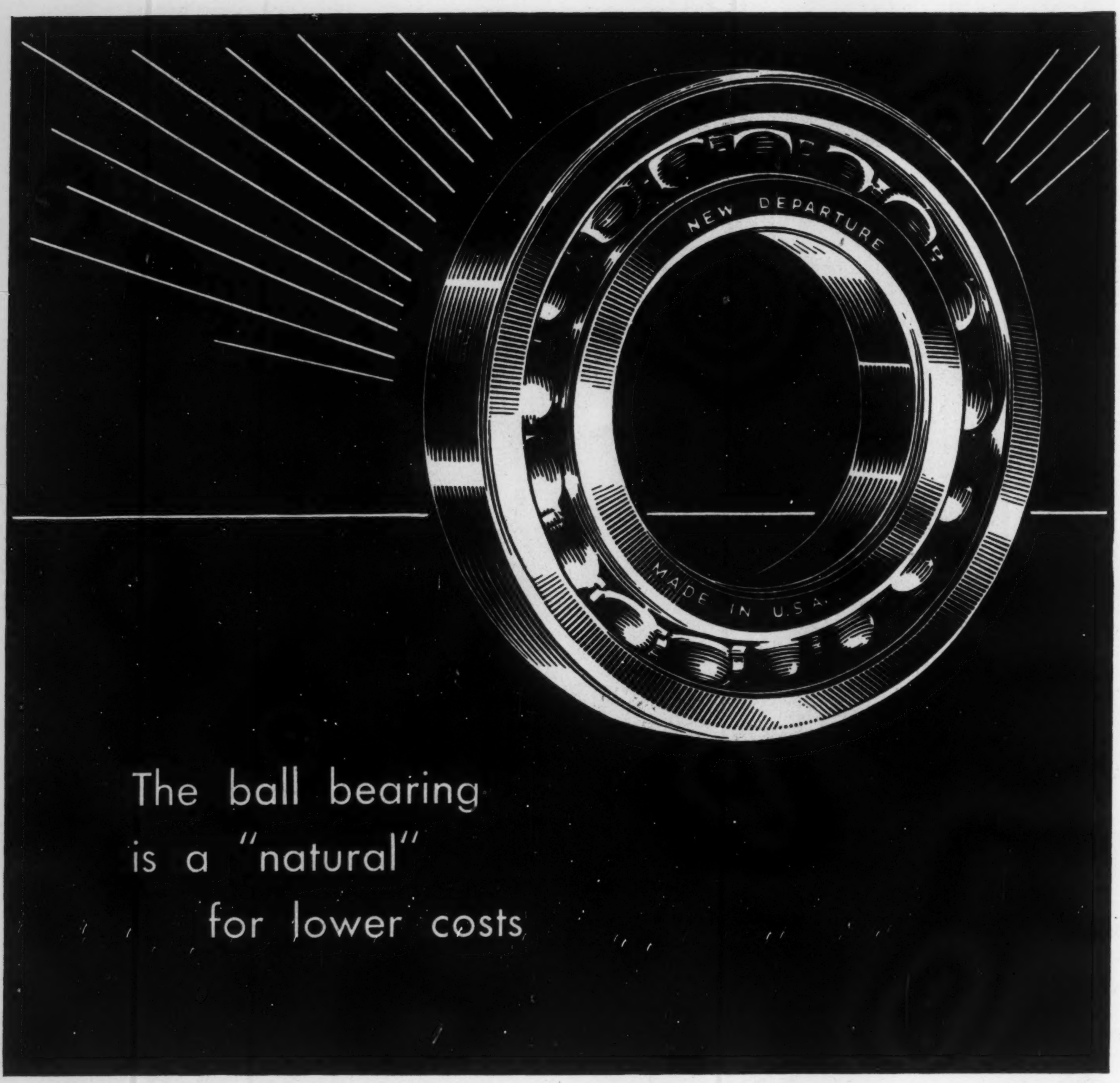
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MACHINE DESIGN is indexed in Industrial Arts Index and Engineering Index Service, both available in libraries generally.

A 29¼-lb. rainbow trout caught by Carl Haacke at Lake Pend Oreille, Idaho with a Monel line—one of the six biggest fish caught on Monel line which won awards in the latest Field & Stream Contest.

How to get the Big Ones... 'Way Down Deep

Fishermen used to have a devil of a time hooking fish like this in hot weather.

Trouble was that big fish like to stay way down on the cool lake bottom. Ordinary trolling line just wouldn't go down there.

All sorts of gadgets were tried. Trick sinkers and attachments were devised to get the hook down where the fish could grab it. The lines themselves were coated with heavy substances to make them sink.

Finally, *metal* lines were given a trial. They went down all right. But other difficulties came up.

They were too heavy. Too thick, too awkward altogether. To be flexible enough for easy handling, the wire line had to be light and fine. To be fine, the metal had to be very strong.

The metal also had to be rustless . . . corrosion-resisting . . . and tough to stand the twisting, diving, leaping yanks of a fighting fish.

Then the news came down from the "big muskie" lakes of Canada about the discovery of a line that revolutionized deep trolling: MONEL Line.

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Perhaps, like the manufacturer of trolling line, your problem is one of wire. Outline your task to us. We'll forward samples of recommended wire for test. Monel and all the Inco Nickel Alloys are the "task metals" of industry . . . ready to help whenever you need tough metals for tough jobs. They're available in all forms.

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It takes 4 spools to hold 600 feet of copper line; only 2 spools for the same length and strength of Monel line.

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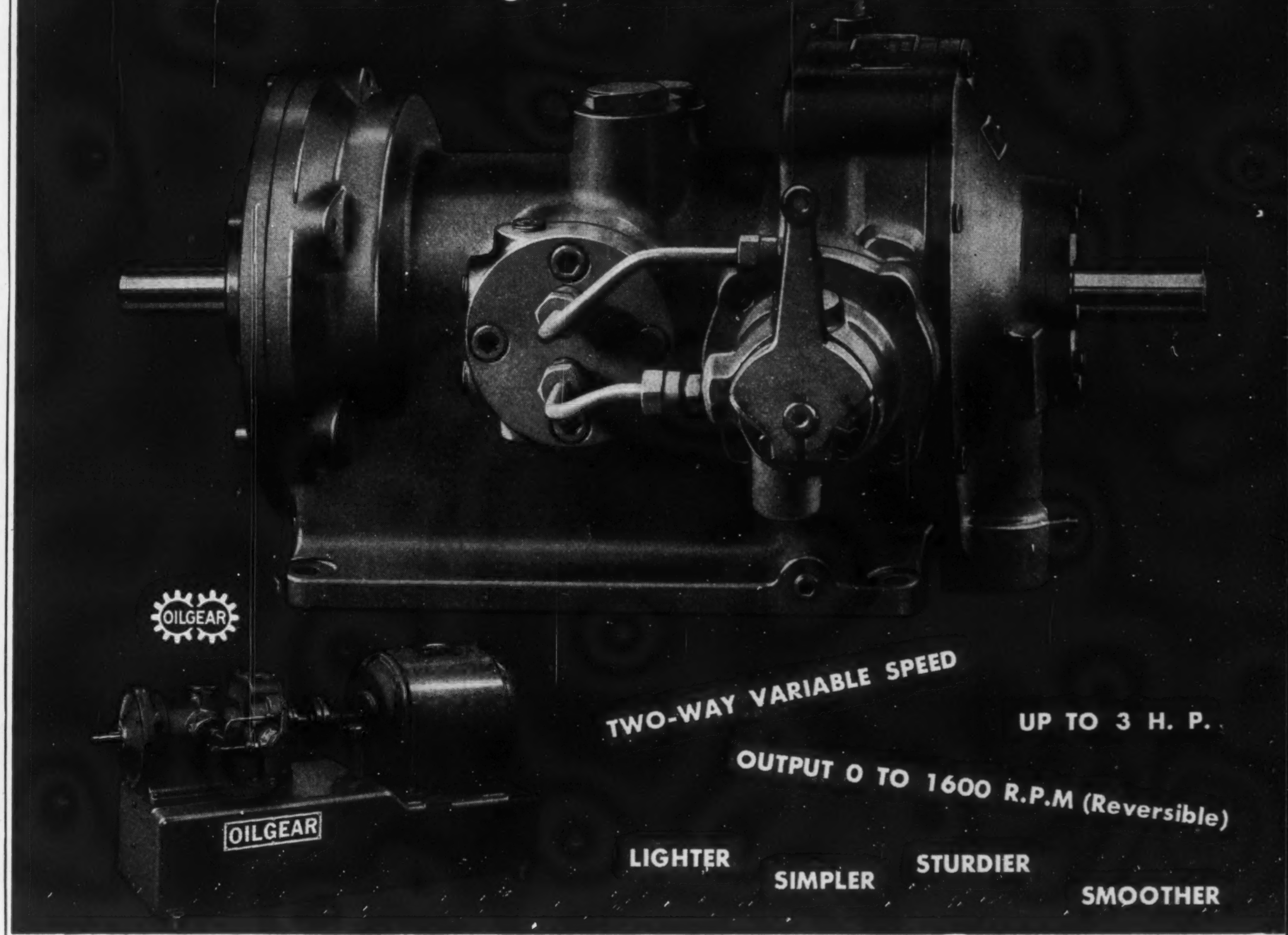

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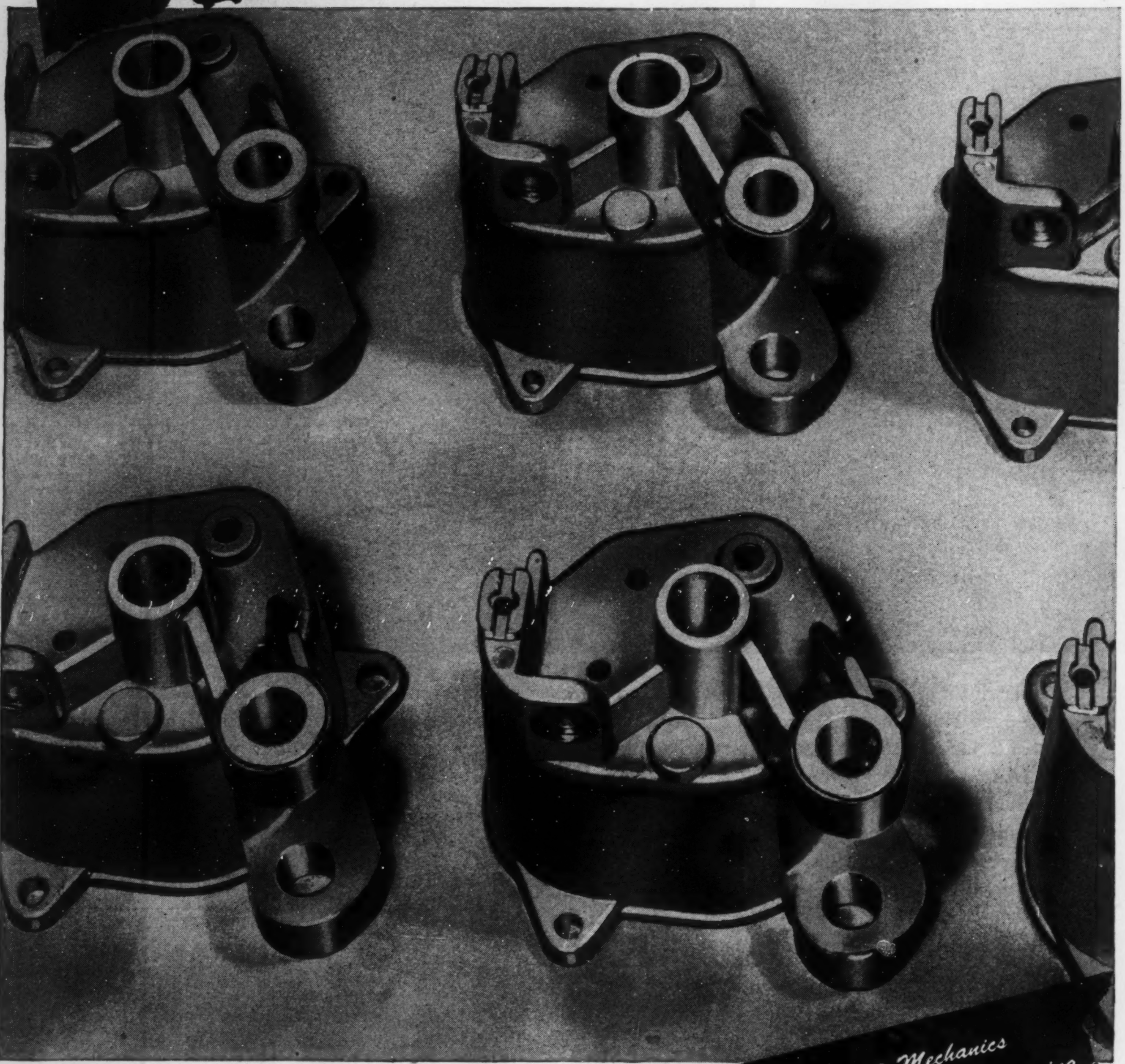

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3 Lock nut clamps assembly securely to shaft and is prevented from loosening by serrated lock washer.

4 [illegible]

5 True flat surfaces assured for nut pressure surface.

6 [illegible]

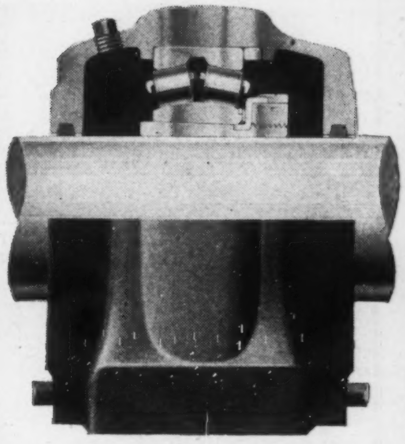
7 Casting spotted for dowel hole to locate unit on support. Slotted holes for foundation bolts.

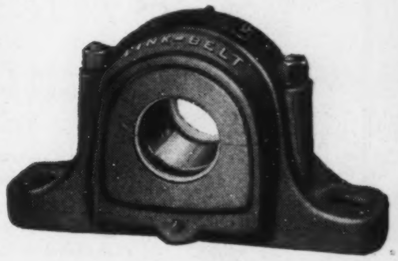
8 [illegible]

9 Tapped holes in cap take standard screw to raise cap off base without damage to finished surface.

10 [illegible]

11 Bearings can be either fixed or floated axially. "C" spacers may be removed or inserted as required.





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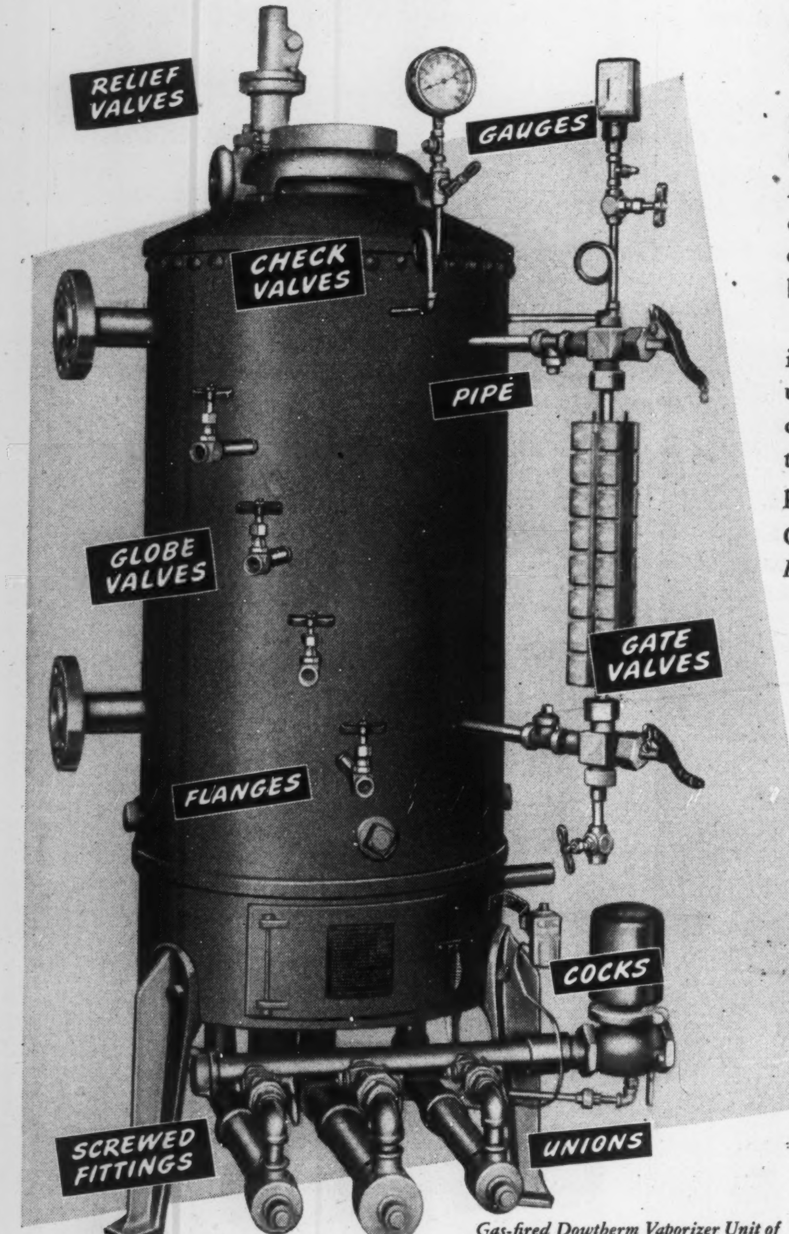

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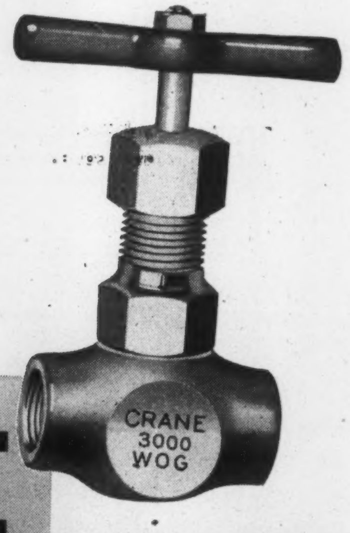

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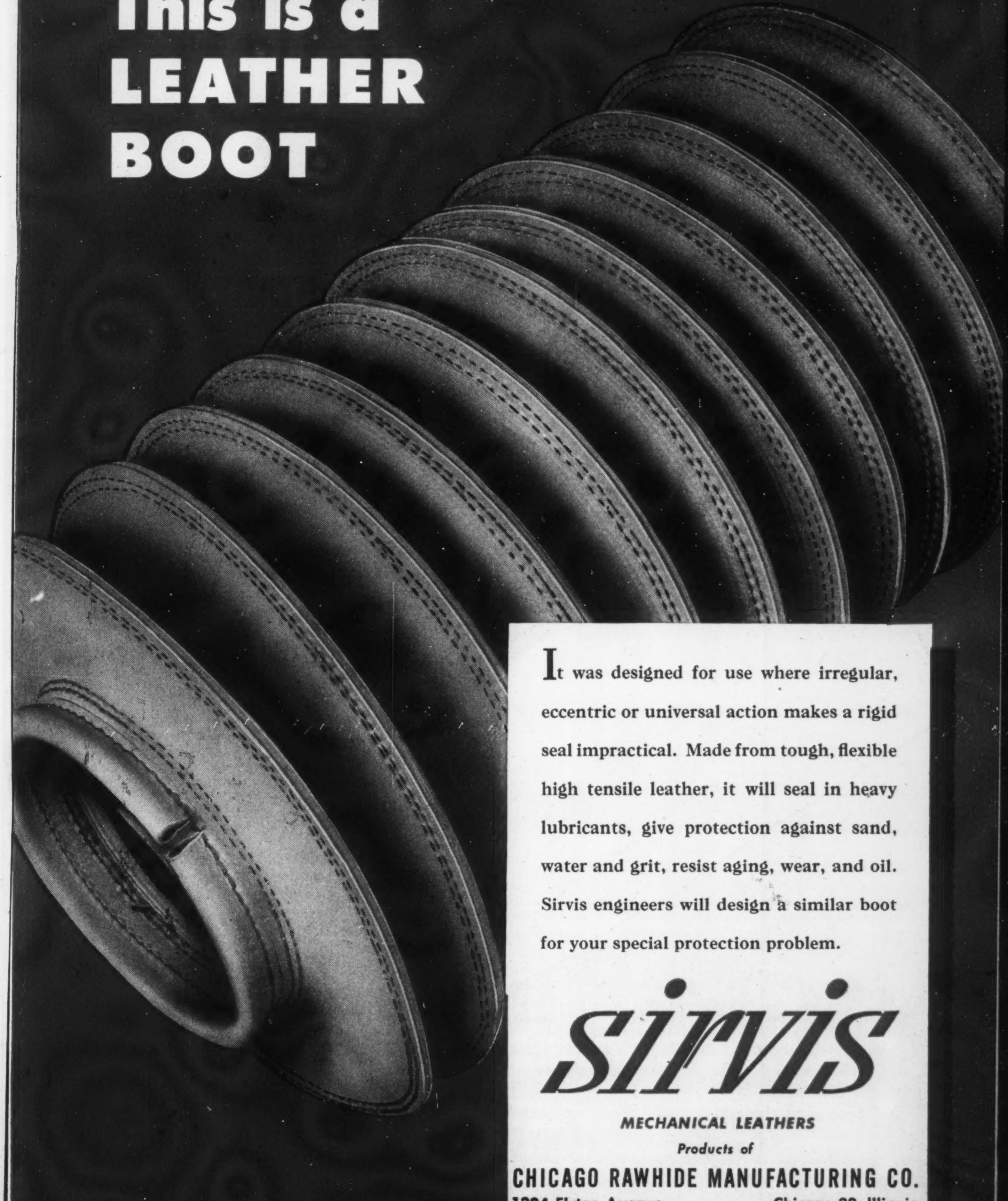

This is a LEATHER BOOT

It was designed for use where irregular, eccentric or universal action makes a rigid seal impractical. Made from tough, flexible high tensile leather, it will seal in heavy lubricants, give protection against sand, water and grit, resist aging, wear, and oil. Sirvis engineers will design a similar boot for your special protection problem.

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- A SAFE, *manual reversing controller* that eliminates confusion where reversal is non-automatic.
- A SIMPLE, inexpensive way to provide reversing feature in combination with magnetic operation.
- Compact tumbler type . . . double throw . . . locks in either position.

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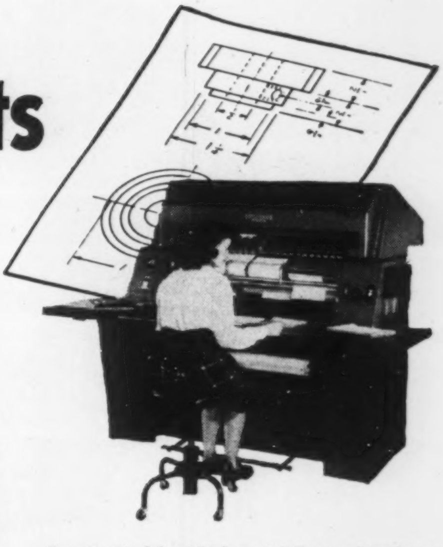
Use the simple, easy way to reproduce your engineering drawings—forms—specifications—bulletins! With Bruning BW equipment, you can have direct line reproduction in seconds—without muss, gadgets, fumes or odors! You can have BW Prints on cut sheets or roll stock—black or colored line BW paper prints on white backgrounds—light, regular or card-weight BW prints—black or colored line prints on green or pink tinted backgrounds—cloth or transparent paper prints! Bruning BW Printer-Developers are the last word in simple, efficient operation—and even large volume production requires only *one* operator. Get complete details on the Bruning BW Process—mail the coupon.



Bruning Model 91 "Volumatic" Printer-Developer —for large volume production.

No Gadgets!

No unnecessary gadgets on Bruning BW equipment! The few controls necessary are simple in operation, and are all within easy reach of the operator at all times. This simplicity of control makes it possible for even inexperienced operators to learn to use BW equipment within a short time.

No Plumbing!

Unlike blue print equipment, BW equipment requires no plumbing. You can install it anywhere in drafting room or office. Machine illustrated is the Model 41 Printer-Developer, designed for medium volume production. The BW line includes printers and developers for every need.

No Odors!

The Bruning BW process is not dependent upon vapor fumes for developing prints—needs no blowers nor vents, thus can be operated in any location. There are no obnoxious odors to irritate operators, and the prints are odorless. Photo shows simplicity of feeding cut sheets into Model 91.

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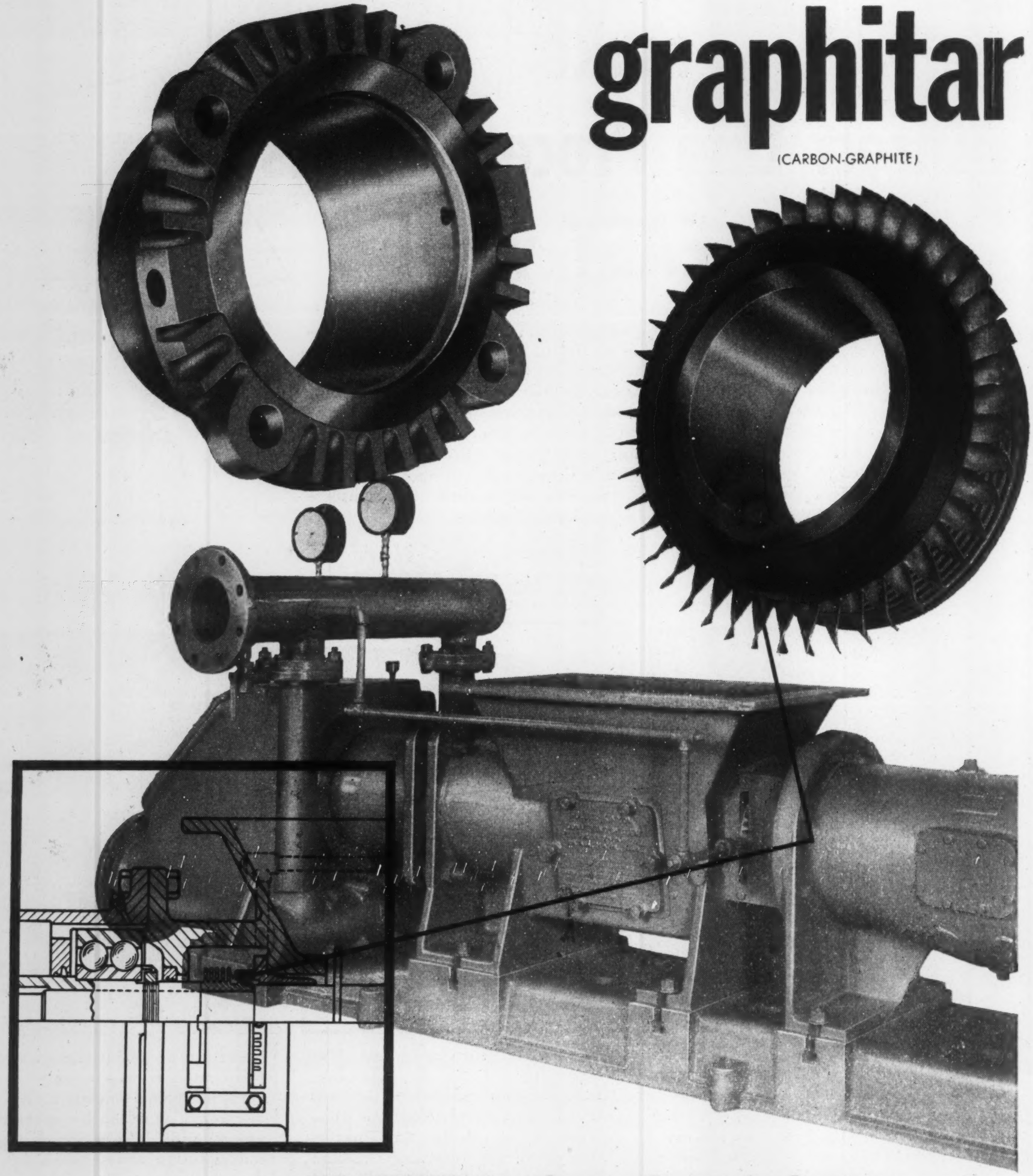
graphitar

(CARBON-GRAPHITE)



GRAPHITAR throughout industry

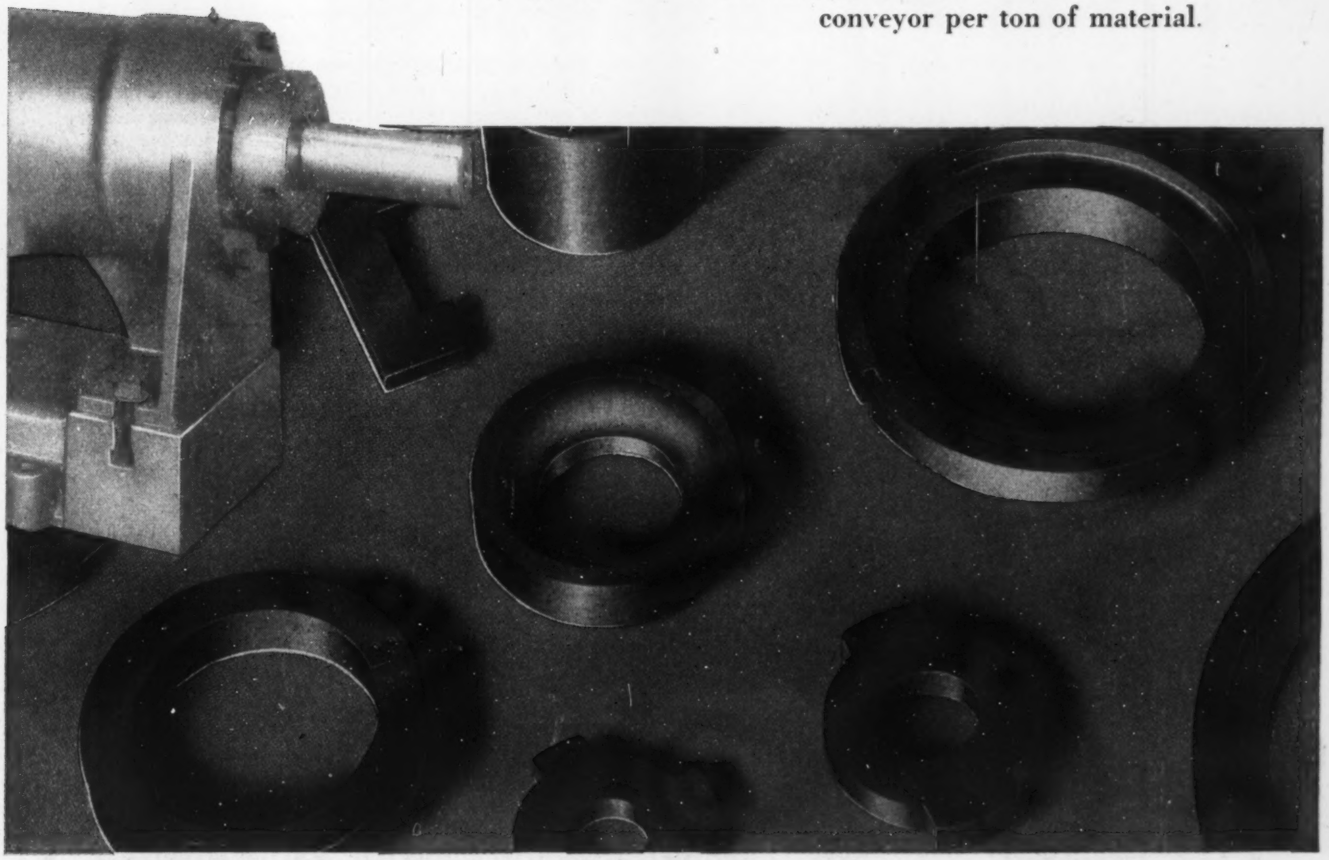
GRAPHITAR parts are bringing trouble-free operation at low cost to many types of mechanisms throughout industry. *Molded of carbon and graphite* and finished to close tolerances, GRAPHITAR seals, rings, pistons, cylinder liners, and other parts operate satisfactorily without lubricant—they are mechanically strong—chemically inert—unaffected by temperature extremes—and they are exceptionally lightweight. We are equipped to mold GRAPHITAR to any practical shape and to finish it to tolerances as close as .0005″ in small sizes. Our engineers will be glad to study sketches of your products and show you where GRAPHITAR parts will improve mechanical performance at lower cost. *Ask for 44-page catalog.*

THE UNITED STATES GRAPHITE

seal keeps out gritty materials from pump bearings

Fuller-Kinyon Type H Stationary Pump employs Graphitar Seal Ring to protect Ball Bearings against cement and other gritty materials in hopper

Cement, pulverized limestone, phosphate, feldspar, and other pulverized products handled so efficiently by the Fuller-Kinyon Type H Stationary Pump *can't work into the shaft bearings and cause abrasive destruction.* WHY? Because the material in the hopper is sealed from the bearings when pump is in operation and under pressure by means of a GRAPHITAR seal ring (see Illustration). In cement plants, the cement pump may be used under the silo where the head above the hopper may be from 70 to 80 feet. Under these conditions, it will be appreciated that the seal is *subject to considerable pressure.* Air piped from the header aids in keeping the ring clean. The GRAPHITAR seal offers excellent resistance to wear arising from shaft rotation, it requires no lubrication, and it *seals dependably day after day* to help make this Fuller-Kinyon pump a most economical conveyor per ton of material.



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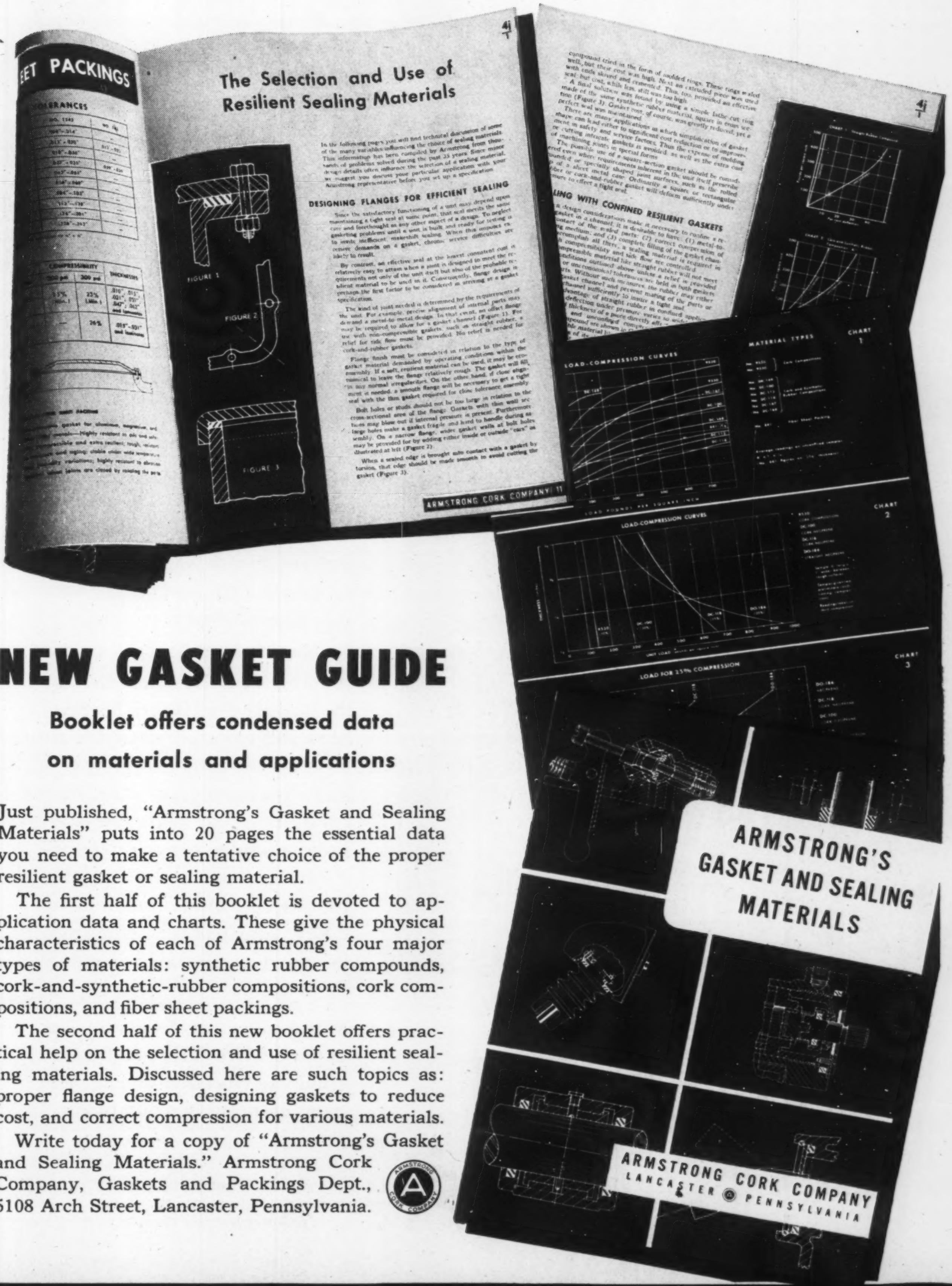
Precision METAL CRAFTSMEN SINCE 1890 ★ ★ ★ ★


SHEET PACKINGS
The Selection and Use of Resilient Sealing Materials
DESIGNING FLANGES FOR EFFICIENT SEALING
FIGURE 1
FIGURE 2
FIGURE 3
ARMSTRONG CORK COMPANY 11
SEALING WITH CONFINED RESILIENT GASKETS
LOAD-COMPRESSION CURVES
MATERIAL TYPES
CHART 1
CHART 2
LOAD FOR 25% COMPRESSION
CHART 3
ARMSTRONG'S GASKET AND SEALING MATERIALS
ARMSTRONG CORK COMPANY
LANCASTER PENNSYLVANIA

NEW GASKET GUIDE

Booklet offers condensed data on materials and applications

Just published, "Armstrong's Gasket and Sealing Materials" puts into 20 pages the essential data you need to make a tentative choice of the proper resilient gasket or sealing material.

The first half of this booklet is devoted to application data and charts. These give the physical characteristics of each of Armstrong's four major types of materials: synthetic rubber compounds, cork-and-synthetic-rubber compositions, cork compositions, and fiber sheet packings.

The second half of this new booklet offers practical help on the selection and use of resilient sealing materials. Discussed here are such topics as: proper flange design, designing gaskets to reduce cost, and correct compression for various materials.

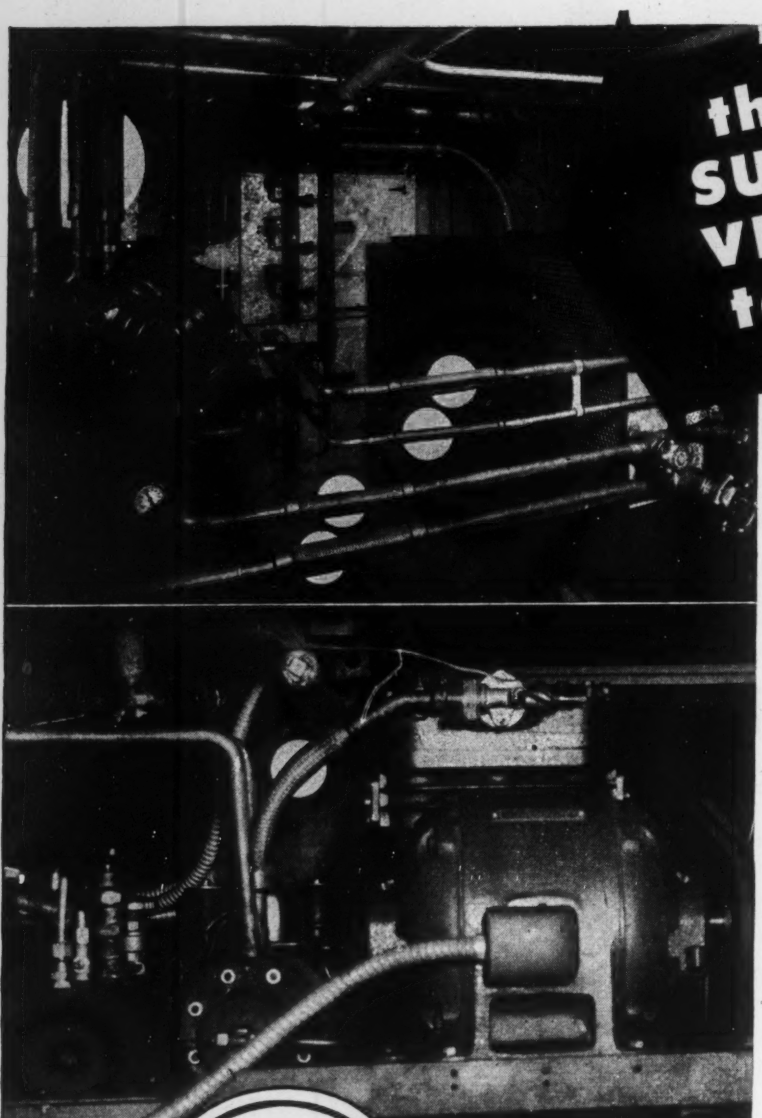
Write today for a copy of "Armstrong's Gasket and Sealing Materials." Armstrong Cork Company, Gaskets and Packings Dept., 5108 Arch Street, Lancaster, Pennsylvania.

ARMSTRONG'S GASKETS • PACKINGS • SEALS

... for high and low frequency

VIBRATION DAMPING

there's a REX SUPER-SERVICE VIBRA-SORBER to fit the Job!



Absorbing vibration near its source with Rex Super-Service Vibra-Sorbers is the *sure* way to prevent the damage vibration can cause to pipe lines and connected equipment.

High or low frequency vibrations are effectively handled by the proper Rex Vibra-Sorbers. Sizes and types are available to meet a wide range of temperature, pressure and corrosion conditions. The "Super-Service" prefix denotes proven dependability in tough operating conditions . . . Made possible by CMH engineers' thorough knowledge of the Science of FLEXONICS.*

Write today for details on Rex Super-Service Vibra-Sorbers to eliminate vibration damage and dampen noise in your plant.

FLEXONICS at work!

*the science of FLEXONICS . . . "the controlled bending of thin metals for use under varying conditions of temperature, pressure, vibration and corrosion" . . . is exemplified in the basic products of Chicago Metal Hose Corporation.

"FLEXON" *identifies C. M. H. products, which have served industry for more than 45 years.*

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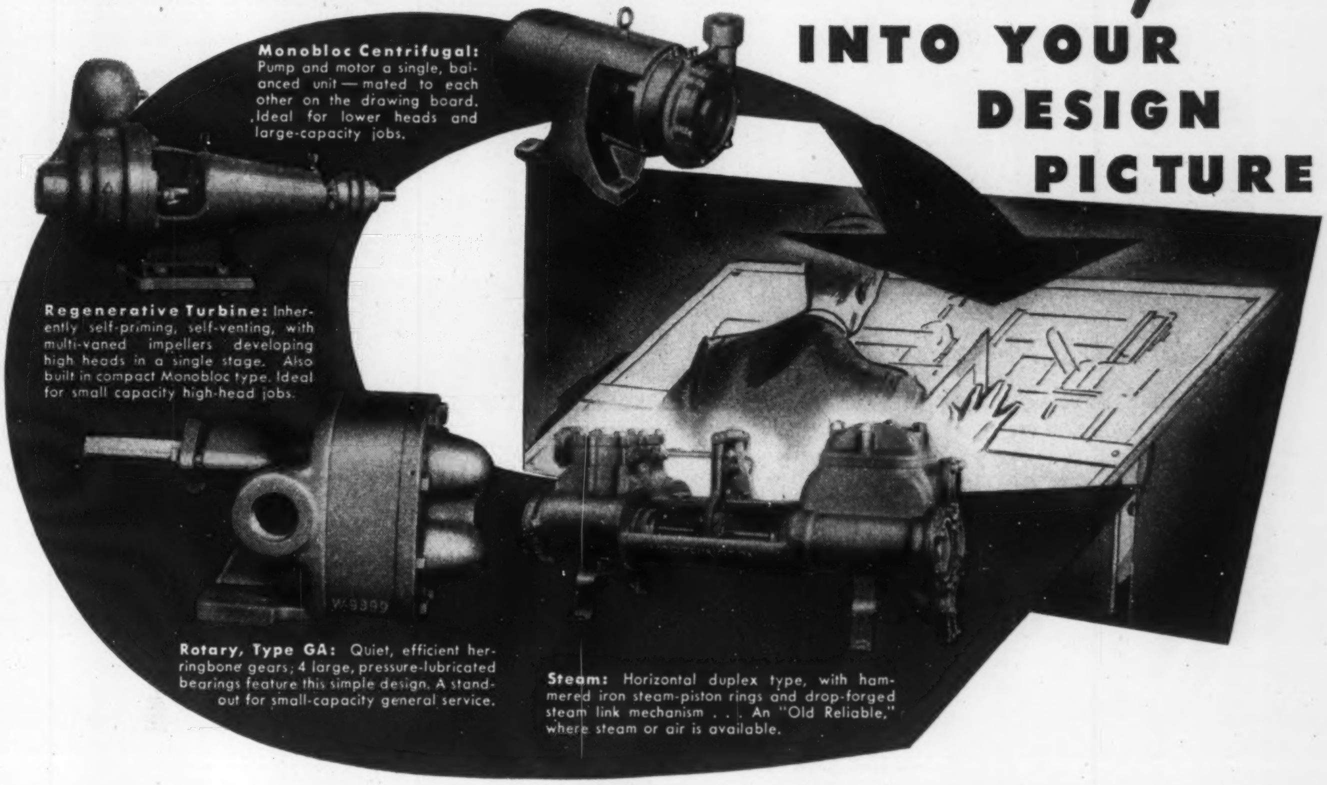
It's Easier to Fit Pumps INTO YOUR DESIGN PICTURE



Monobloc Centrifugal: Pump and motor a single, balanced unit — mated to each other on the drawing board. Ideal for lower heads and large-capacity jobs.

Regenerative Turbine: Inherently self-priming, self-venting, with multi-vaned impellers developing high heads in a single stage. Also built in compact Monobloc type. Ideal for small capacity high-head jobs.

Rotary, Type GA: Quiet, efficient herringbone gears; 4 large, pressure-lubricated bearings feature this simple design. A standout for small-capacity general service.

Steam: Horizontal duplex type, with hammered iron steam-piston rings and drop-forged steam link mechanism . . . An "Old Reliable," where steam or air is available.

. . . *when you specify Worthington*

Wherever your equipment design calls for pumps — call on Worthington! In the world's most complete line you'll find exactly the pumps that will team up with your plans to boost product-efficiency, customer-satisfaction — and sales!

The four leaders illustrated cover widely different uses — yet each shows the advanced engineering and rugged construction that assure consistent top performance and long, trouble-free service life.

Worthington Builds 'Em All!

Worthington builds pumps for every application . . . in all types and sizes . . . all heads and capacities . . . handling a great variety of liquids. And backing up every one, the longest and broadest experience in the field is at your service in selecting the right pump for every job . . . another reason why *there's more worth in Worthington.*

To learn how profitably Worthington pumps can fit into *your* product-picture, contact your nearest Worthington District Office or send in coupon below. *Worthington Pump and Machinery Corporation, Merchandising Division, Harrison, New Jersey. 36 District Offices throughout the U. S. A.*

WORTHINGTON

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Centrifugal Pumps • Rotary Pumps
Steam & Power Pumps
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Send latest bulletin on Monobloc Pumps ( ); Regenerative Turbine Pumps ( ); Rotary Pumps ( ); Steam Pumps ( ).

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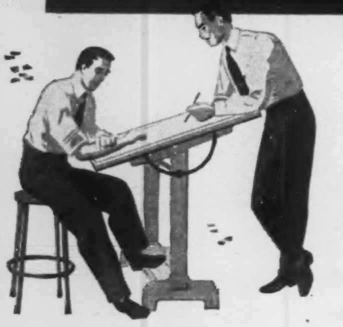
"Bring Out the



To broaden the work range of the machines you design or manufacture . . . to increase their efficiency and versatility and, therefore, their acceptance among machine users . . . consider the case for accurate, variable REEVES Speed Control.

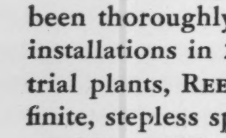
Incorporating an operating principle that has been thoroughly proved in more than 260,000 installations in 25,000 widely diversified industrial plants, REEVES Speed Control provides infinite, stepless speed adjustability for any driven machine. Without shutting down the machine, speed can be altered instantly to meet every change in operating conditions . . . permitting every job to be performed at the exact speed best suited to the requirements of the operation and the skill of the operator. As a result, the REEVES-equipped machine does *more* work and *better* work. Quality is maintained at higher, uniform standards. Quantity of output is increased and production costs lowered.

The REEVES line of variable speed drives is the most complete in the market, consisting of three basic units which are manufactured in a wide range of designs, sizes, capacities, speed ratios and controls, the latter including manual, push button and completely automatic. In addition, REEVES also offers "internal operating parts only" for incorporation within the machine framework. All units are soundly designed and ruggedly constructed, requiring neither special tools nor special training for their maintenance or service.

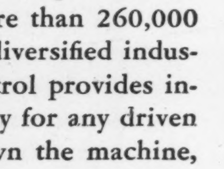
REEVES maintains a nation-wide organization of experienced speed control engineers. Manufacturers of more than 2,100 different makes of machines have already called on these REEVES specialists to assist in adapting REEVES Speed Control to their products as standard equipment. This service is always available to you, and we suggest that you have a REEVES engineer call soon to discuss your particular problems of application. Meanwhile, you can obtain complete details on the entire line of REEVES Speed Control units by writing us right away for the comprehensive, 114-page catalog, H-450A.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

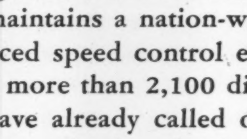
THE 3 BASIC REEVES SPEED CONTROL UNITS



VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over a wide range—2:1 to 16:1. Sizes—fractional to 87 hp.

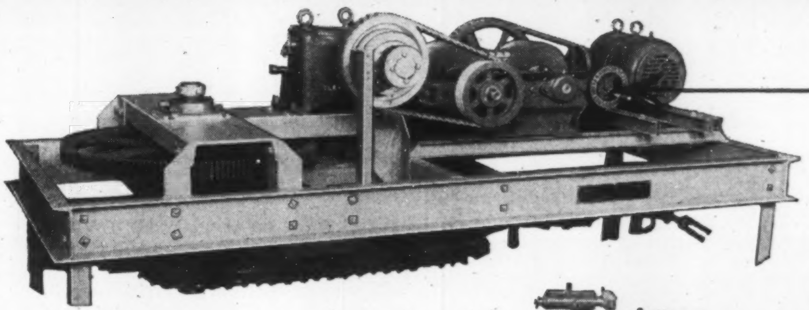


VARI-SPEED MOTOR PULLEY converts any standard constant speed motor to a variable speed drive within 4:1 ratio. Sizes to 15 hp.

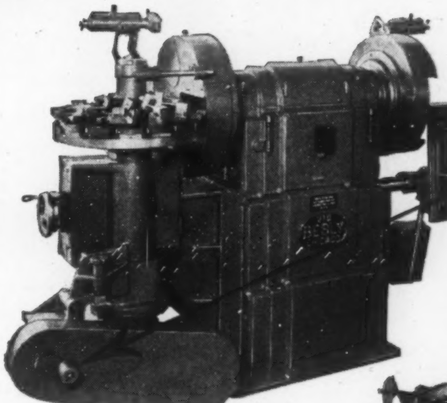


MOTODRIVE combines motor, speed varying mechanism and reduction gears in single compact unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 15 hp.

Best" IN THE MACHINES YOU BUILD WITH REEVES SPEED CONTROL



To assure a smooth, continuous flow of materials along an assembly line, this overhead conveyor drive, manufactured by Anchor Steel and Conveyor Co., Detroit, Michigan, is standardly equipped with a REEVES Variable Speed Transmission. A turn of the convenient handwheel on the REEVES unit provides the exact conveyor speed desired—from 4 to 16 feet per minute—instantly and accurately.



The REEVES Vari-Speed Motor Pulley is standard equipment on this single spindle grinder, manufactured by Charles H. Besly and Company, Chicago, Illinois. Speed of rotation on the multiple station feed holding the work is varied by the REEVES unit to provide the exact speed required, as determined by the size of the pieces ground and by the loading ability of different operators.

This woolen shear, manufactured by Curtis & Marble Machine Co., Worcester, Mass., brushes and shears the nap, thereby cleaning up the pattern and producing a smooth, even surface on woolen and worsted cloth. By means of the REEVES Motodrive, with which the machine is standardly equipped, the operator can obtain instant and accurate changes in operating speed—from 20 to 50 yards per minute—to take care of variations in the type of cloth handled and to obtain maximum production.

Accurate Variable

REEVES Speed Control

Gives the Right Speed for Every Job!

Recognized Leader in the Specialized Field of Speed Control Engineering

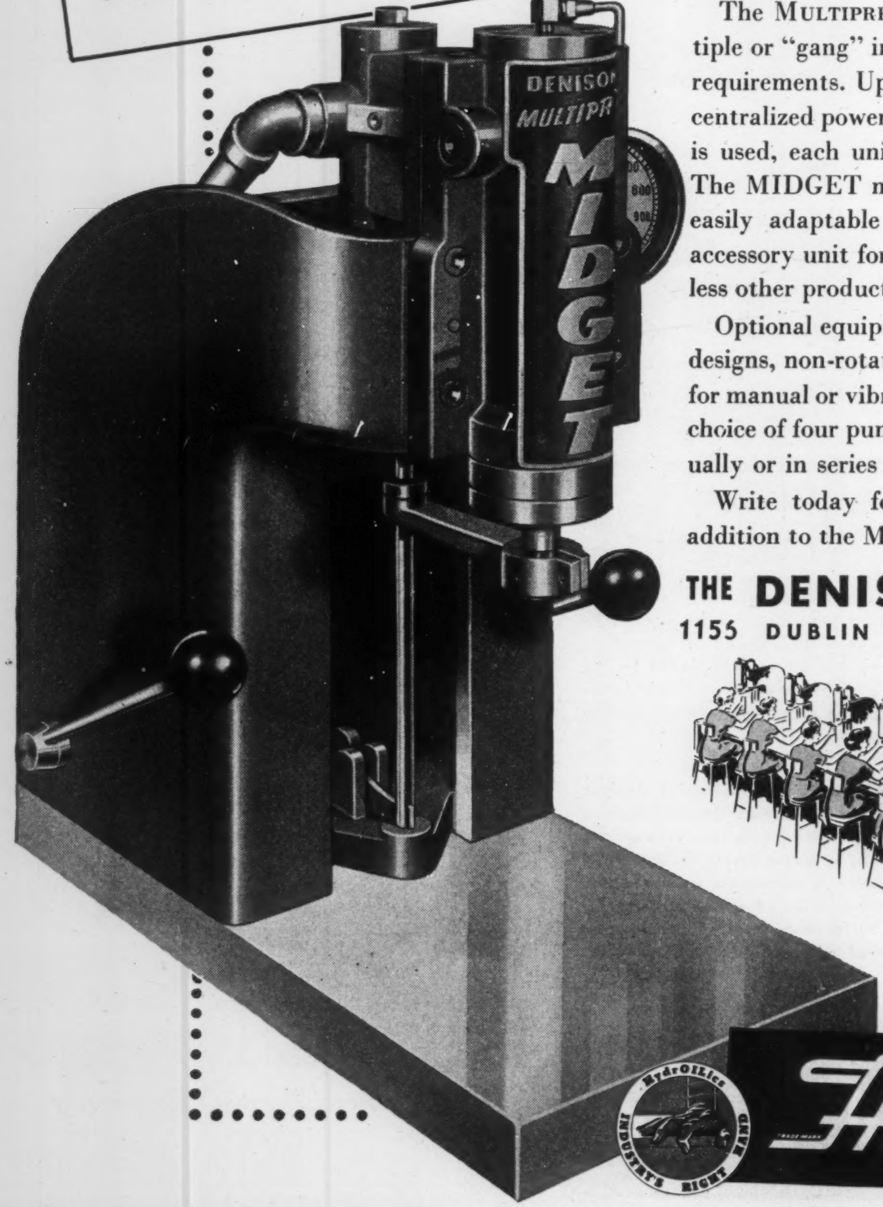
Meet the new

MULTIPRESS MIDGET

...a little press for big production

SPECIFICATIONS (basic unit)

Capacity (ram effort)........................1 ton
Stroke..6″
Ram speed adjustable up to 400 ipm down—600 ipm up
Daylight..............................10″ or 14″
Throat depth..................................5″
Base Plate tooling area (optional). 10″ x 10″ (standard)
Dimensions......24¾″ high x 17″ deep x 18¼″ wide
Weight without base plate...................130 lbs.



Here's the new, low cost, MULTIPRESS MIDGET especially designed for your pressing requirements between 200 and 2000 lbs. ram effort. All the famous, production-boosting features of the larger size MULTIPRESSES are found in the MIDGET. Vibratory repeat strokes, fast approach and slow pressing speed, either dual hand lever or foot pedal safety controls—plus adjustable stroke length, ram speed and pressing effort.

The MULTIPRESS MIDGET is ideally suited for multiple or "gang" installations and for successive operation requirements. Up to 12 units may be used with a single, centralized power source. When more than one MIDGET is used, each unit has individual pressure adjustments. The MIDGET may be operated in any position, and is easily adaptable to other hydraulic machinery as an accessory unit for pressing, feeding, clamping and countless other production tasks.

Optional equipment includes choice of three base plate designs, non-rotating ram guides, interchangeable valves for manual or vibratory action, adjustable daylight, and a choice of four pumping units for operation either individually or in series of 4, 8 or 12 MULTIPRESS MIDGETS.

Write today for descriptive bulletin on this newest addition to the MULTIPRESS line.

THE DENISON ENGINEERING COMPANY
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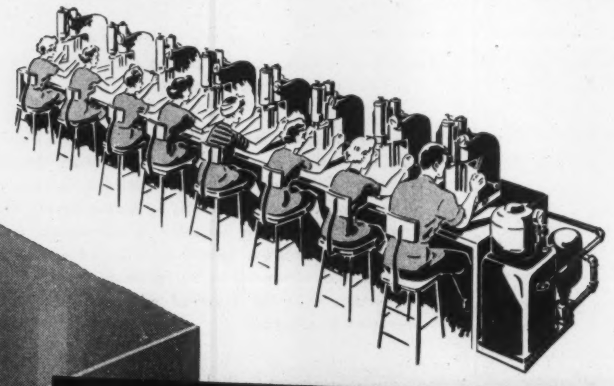

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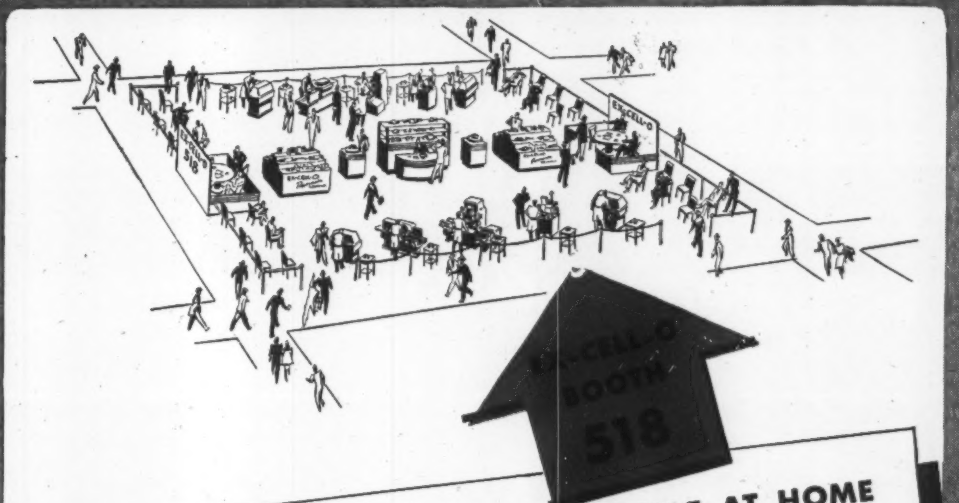
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EX-CELL-O
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. . . new and improved Ex-Cell-O precision machine tools—with definite advancements in automatic cycling, greater output, increased versatility, and labor-saving characteristics—all designed to aid manufacturers in reducing their production costs. Be sure to visit the Ex-Cell-O Exhibit at the Machine Tool Show at the DODGE-CHICAGO PLANT, September 17 to 26 (Booth 518). ***You'll be made welcome there!***

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WG-4

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FOR BETTER HYDRAULIC DEVICES
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These lamps keep
an eye on the sun

The sun sets late in summer, early in winter. But whatever the season, street lamps go on at exactly the right time. In most cities, an ingenious timing device turns the lights on and off automatically. It's operated by a Telechron synchronous electric motor.

The automatic lamplighter is typical of the exacting jobs performed by Telechron motors. These versatile motors have been used successfully in clocks and timing devices for 25 years—and more. New applications are being worked out every day by Telechron engineers, working with manufacturers. No matter how unusual or difficult your application, a Telechron motor may be the answer.

Telechron motors can be adapted to many types of automatic timing, switching, recording and control equipment — complicated program mechanisms as well as simple switches. Self-starting, they reach rated speed almost instantly. They operate in perfect synchronism with all standard commercial frequencies — *can't run faster or slower.* Conservative torque ratings, precision building and Telechron's exclusive sealed-in oiling system assure years of dependable service.

A Telechron motor gives you the advantages of Telechron's pioneering research. For over 25 years, Telechron has been the largest producer of synchronous electric motors. They're all Underwriters Laboratories approved. Telechron's *application engineers* will be glad to study your needs. Address Motor Advisory Service, Dept. C, Telechron Inc., Ashland, Massachusetts.

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Stoker, Oil Burner and Temperature Controls
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SYNCHRONOUS MOTORS

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FRACTIONAL HORSEPOWER GEARING
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STOP

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SMALL GEARS

MANY of America's *most particular* buyers specify "G.S." when they want *better* Small Gears. They have learned that we can be relied upon to deliver correctly designed gears in any quantity, manufactured to the highest standards of uniform accuracy. Here, the most elaborate methods of inspection are employed . . methods requiring painstaking care and the use of every modern measuring device. Small wonder G.S. Fractional Horsepower Gears give smoother, more dependable performance. Over a quarter century of *specializing* in making *better* Small Gears exclusively has resulted in the development of a high degree of efficiency in our engineering and manufacturing techniques. Let our highly skilled engineers lend you valuable aid on the Small Gears you need. Tell us now, just how we can best serve you.

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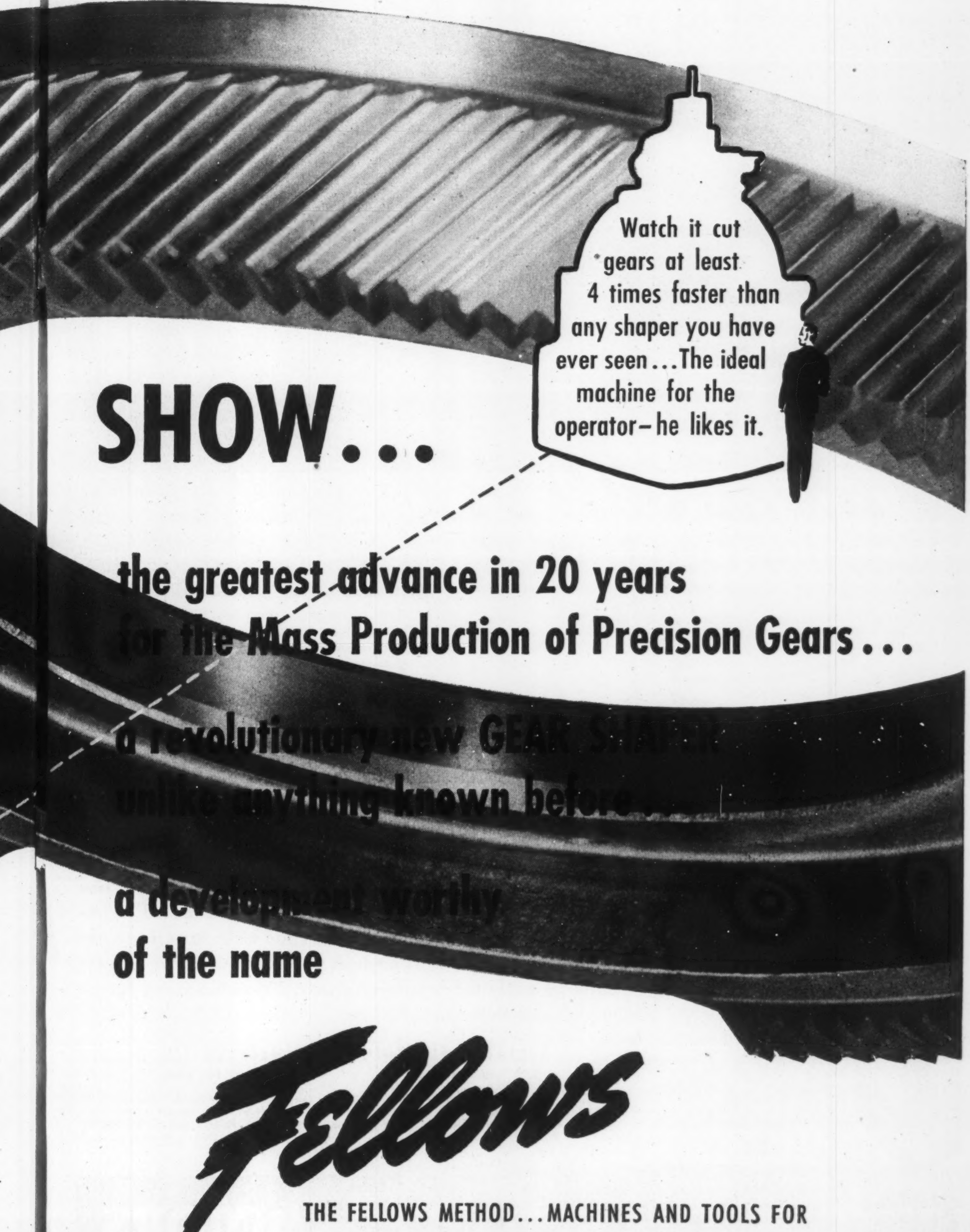
Booth 107
FELLOWS
The Biggest News in modern gear cutting!



Watch it cut gears at least 4 times faster than any shaper you have ever seen...The ideal machine for the operator—he likes it.

SHOW...

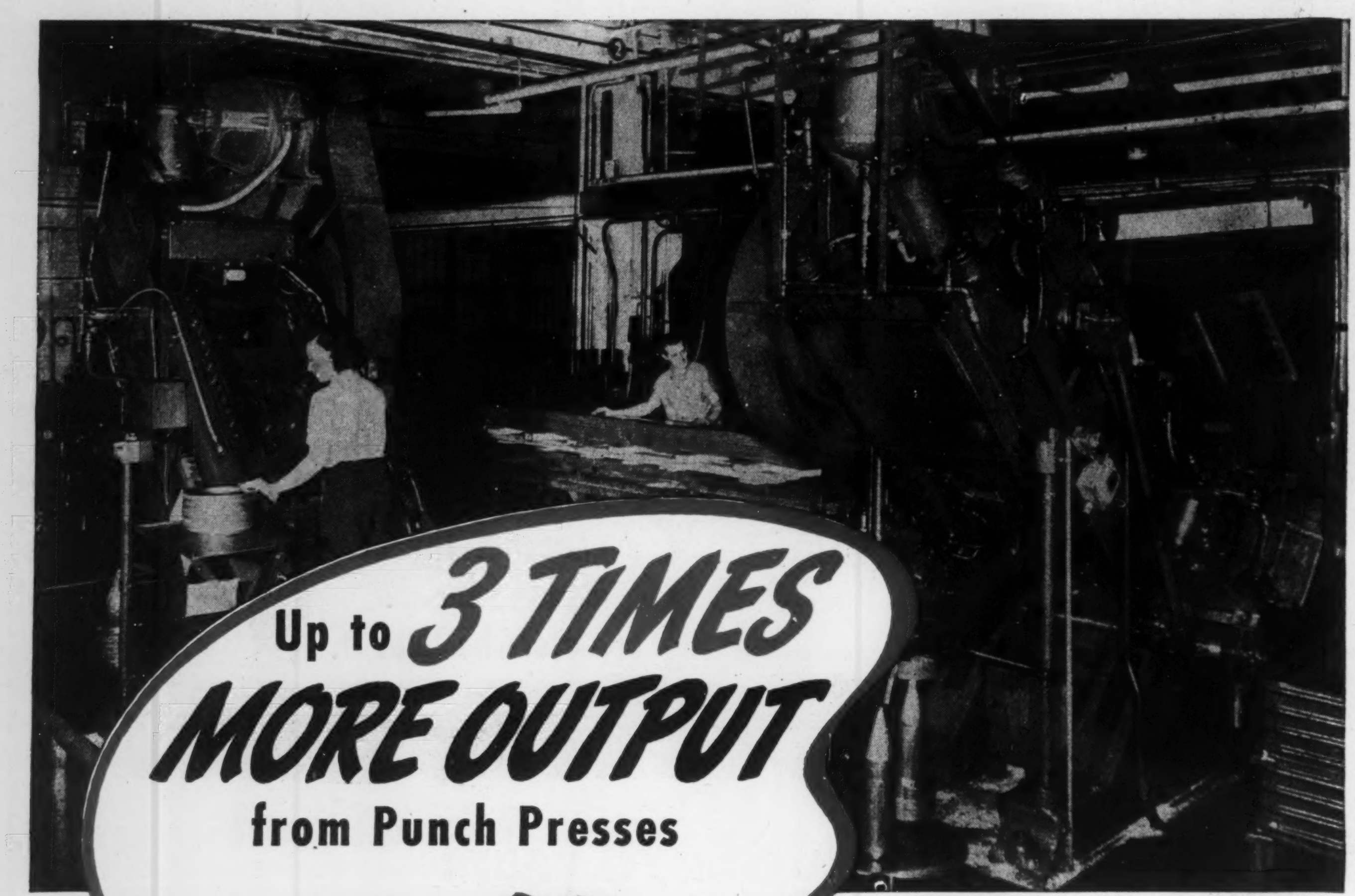
the greatest advance in 20 years for the Mass Production of Precision Gears...

a revolutionary new GEAR SHAPER unlike anything known before...

a development worthy of the name

Fellows

THE FELLOWS METHOD...MACHINES AND TOOLS FOR ALL OPERATIONS FROM BLANK TO FINISHED GEAR



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With repeat-stroke operation, V★S makes possible 2 to 3 times greater production by providing adjustable speeds to suit a variety of materials and operating conditions.

Don't miss the Operating Exhibit of

RELIANCE V★S DRIVE

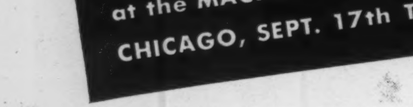
SPACE 302-C

at the MACHINE TOOL BUILDERS SHOW

CHICAGO, SEPT. 17th THRU SEPT. 26th

Reliance V★S Drive makes it possible to adjust machine speed to assure maximum production at the turn of a rheostat knob. Quick, smooth starts and stops—inching speeds for setting up—and remote control are other V★S contributions to efficiency and safety in processing equipment.

V★S, the *All-electric, Adjustable-speed Drive operating from A-c. Circuits,* has a record of improving quantity and quality of production while lowering costs on *every* type of machine on which it has been used. We suggest you write today for reprint of article, "Variable-Speed Jumps Output" and Bulletin 311.



Conveniently-packaged, space-saving V★S Drives are available from 1 to 200 hp.

RELIANCE ELECTRIC & ENGINEERING CO.
1079 Ivanhoe Road • Cleveland 10, Ohio

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Grand Rapids • Greenville, S. C. • Houston • Kansas City • Knoxville • Los Angeles • Milwaukee
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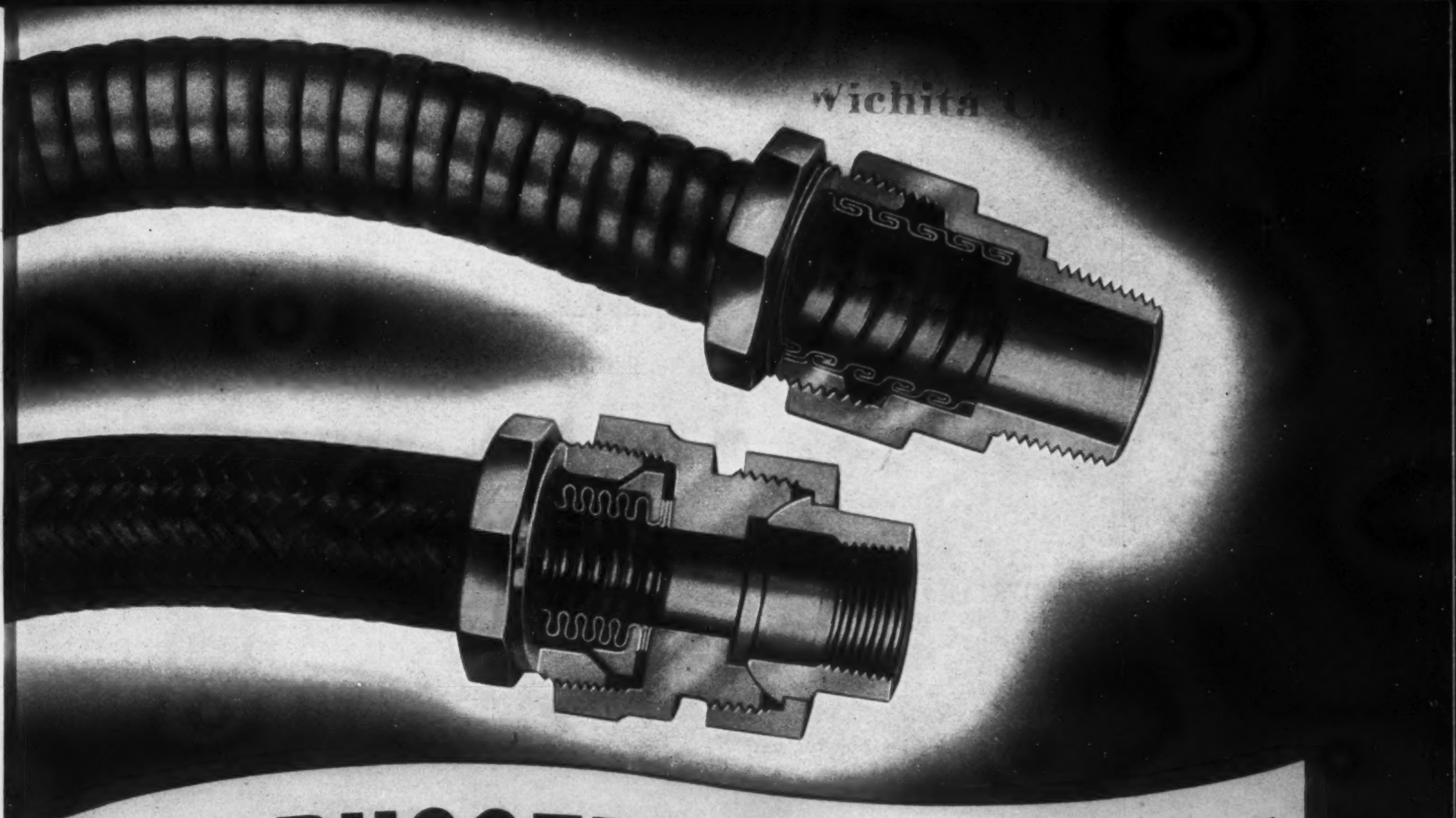
RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"



"TWO RUGGED INDIVIDUALISTS"

Live steam under pressure is a tough medium to handle. It can cause a bad cycle of troubles when it breaks loose.

But daily — in a variety of services and machines — the two types of American Flexible Metal Steam Hose, illustrated above, handle the problem with ease. Both are successful because they are so well constructed of strong metal, yet have practical flexibility.

The type illustrated at the top of the page is constructed of bronze metal strip so formed as to interlock, giving a four-wall metal-to-metal joint, made pressure-tight by asbestos cord packing. Made of bronze — this hose, known as American Type BD-15, is highly resistant to corrosion, moisture, high temperature and pressure. It is a rugged hose, especially adapted to steam service where rough handling is encountered.

The other type illustrated is made from seamless tubing with no seams, laps, welds or joints of any kind. Corrugated for flexibility and covered with one or more wire braids actually woven over the corrugated tubing to give added strength, it is thoroughly dependable for use under high pressure. American Seamless Flexible Metal Tubing is used where 100% tightness plus extreme flexibility is needed to connect moving parts of machinery, absorb vibration in pipe lines or facilitate piping installations in cramped spaces.

ANACONDA

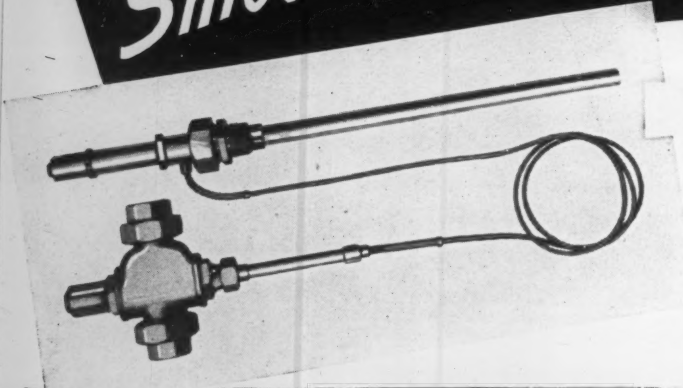
American Metal Hose

THE AMERICAN BRASS COMPANY AMERICAN METAL HOSE BRANCH
General Offices: Waterbury, Conn. • *Subsidiary of Anaconda Copper Mining Company*
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

TURN PAGE FOR OTHER FLEXIBLE METAL HOSE APPLICATIONS ➔

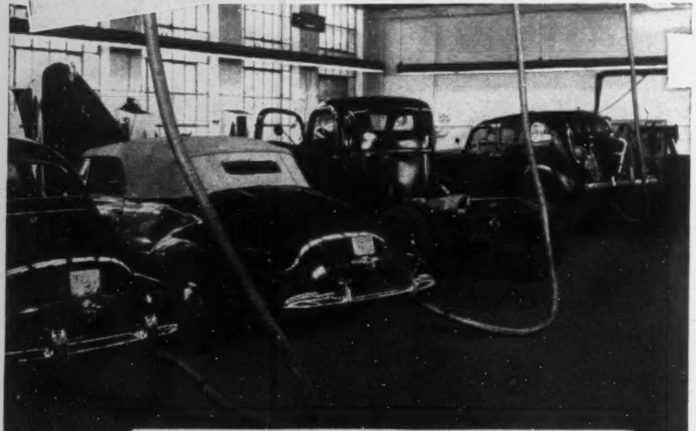
For Better Methods and Smoother Performance

AMERICAN
Flexible
METAL HOSE & TUBING



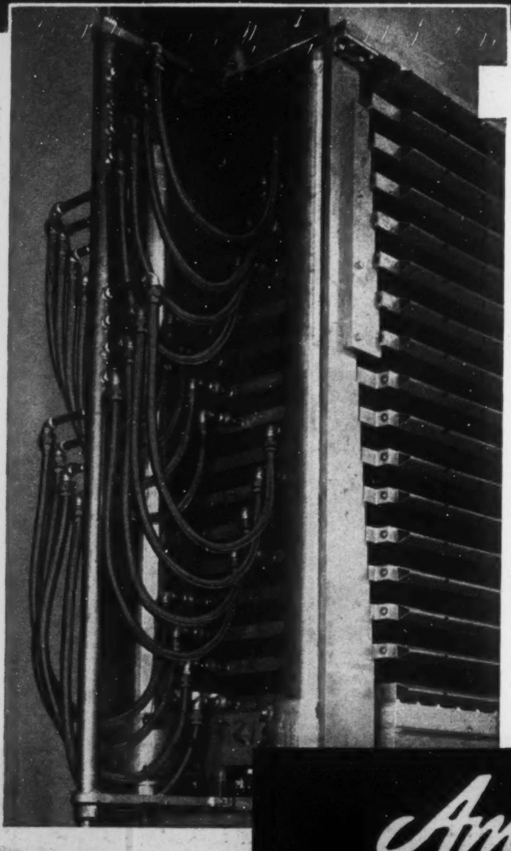
. . for Protecting Delicate Tubing

The delicate capillary tubing on this modern temperature regulator could be easily damaged, were it not for the American Flexible Metal Hose which serves as a protective casing between the thermostat and the valve — insuring safe, continuous operation of the control regulator.



. . for Carrying off Exhaust Gases

Modern garages now have an efficient method of exhausting fatal carbon monoxide gas from closed areas, especially in winter. They use asbestos packed interlocked American Flexible Steel Hose which is easily handled and 100% effective. Being flexible, American Metal Hose does not require exact parking for connecting hose to tail piece. Quickly attached, the result is a "safety path" for deadly gas into a suction system which expels it outside the garage.



. . for Conveying Hot Liquids

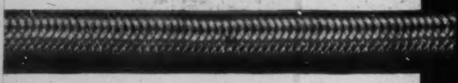
Here American Seamless Flexible Bronze Tubing with bronze wire braid covering conveys hot water under pressure to provide heat in the bonding of plywood. This press is a fifteen-opening hot plate press with a capacity of 925 tons — a good example of how American Seamless is used for connecting moving parts of heavy machinery.

As an original installation, American Flexible Metal Hose and Tubing pays dividends "right from the start": easily and quickly assembled; absolutely tight and dependable; sufficiently flexible to provide for slight lineal contraction and expansion; reduces the noise and danger of vibration; requires little or no maintenance attention.

For further information write for literature. Please ask for the advice of our Technical Department on unusual problems.

47288

ANACONDA



American Metal Hose

THE AMERICAN BRASS COMPANY — AMERICAN METAL HOSE BRANCH
General Offices: Waterbury, Conn. • Subsidiary of Anaconda Copper Mining Company
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Any Speed They Want . . .

AT THEIR FINGER TIPS

Those 3 Manufacturers Increased Output, Reduced Maintenance, and Improved Product Quality with

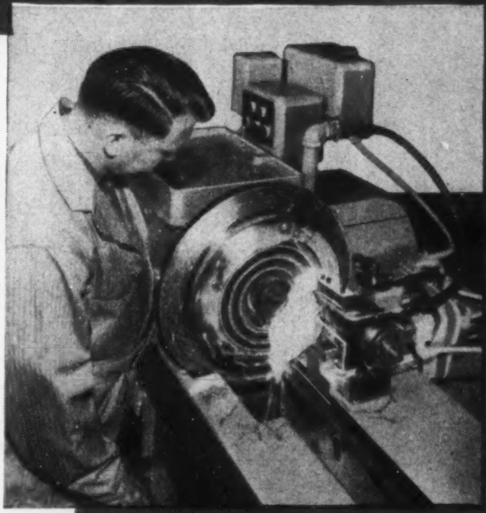
THY-MO-TROL

G.E.'s Electronic Adjustable Speed Drive

66% Extra Gain in Output

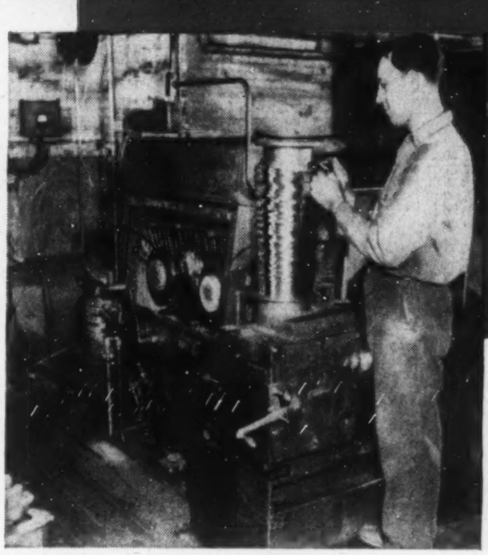
To speed the cutting of a groove (.0065 inches wide, .0070 inches deep) on a cartridge wheel, a metals working plant installed this modern Sundstrand automatic lathe with special tooling, in place of an older type machine. Equipped with a two-speed, 2-to-1 ratio motor drive, the lathe turned out 3 pieces per hour.

By replacing the two-speed drive with electronic stepless speed control, the lathe's output was increased to 5 pieces per hour—an extra gain of 66 per cent, thanks entirely to Thy-mo-trol.



Better Quality of Wire, Less Breakage

With this one wire-drawing machine and Thy-mo-trol drive, Scovill Mfg. Co., can draw wire of several different sizes, because Thy-mo-trol's wide speed range provides the right speed for maximum production of every size wire. Thy-mo-trol not only provides a wide range of speeds, but it can hold each speed constant, regardless of load change. This has improved quality, particularly in the threading operation where the load varies greatly. And Thy-mo-trol's smooth acceleration minimizes wire breakage, and saves wear on the machine and dies.



See-Saws as She Breathes

Here's a unique application of Thy-mo-trol to a new-type oscillating bed for combating the crippling effects of polio. Built by Respir-Aid, Inc., the new bed is mounted on a motor-driven frame which the Thy-mo-trol drive see-saws in rhythm to the patient's breathing. By simply turning a small knob which electronically controls the speed of the driving motor, this attendant regulates the speed of see-saw motion.

You, too,

can give your machines these advantages—

1. Wide Speed Range
2. Constant Speed, Regardless of Load
3. Stepless Speed Control

For more information about these inherent characteristics of Thy-mo-trol, and how it really works, ask your nearest G-E office for Bulletin GET-1223. *Apparatus Department, General Electric Co., Schenectady 5, N.Y.*

GENERAL ELECTRIC

PERMANENT RESILIENCE

Resilient parts made from HYCAR synthetic rubber *stay* resilient. That's partly because of HYCAR's unusual chemical stability—its resistance to oil and gas, acids and most other chemicals. And parts made from HYCAR are extremely resistant to the effects of oxidation, sunlight, and normal aging. A HYCAR sealing ring, for example, will maintain a positive seal through years of service even when constantly exposed to oils and acids inside the pipe, and sunlight and salt air outside.

Other unusual and valuable properties are listed in the box at the right. But most important, these properties may be had in an almost limitless number of combinations, each designed to meet the specific service conditions of the finished part. Parts made from HYCAR have seen service in *every* industry, giving long life, dependability, and economical operation.

That's why we say ask your supplier for parts made from HYCAR. Test them in your own applications, difficult or routine. You'll learn for yourself that it's wise to use HYCAR for long-time, dependable performance. For more information, please write Dept. HN-8 B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

CHECK THESE SUPERIOR FEATURES OF HYCAR

1. *EXTREME OIL RESISTANCE — insuring dimensional stability of parts.*
2. *HIGH TEMPERATURE RESISTANCE—up to 250° F. dry heat; up to 300° F. hot oil.*
3. *ABRASION RESISTANCE—50% greater than natural rubber.*
4. *MINIMUM COLD FLOW—even at elevated temperatures.*
5. *LOW TEMPERATURE FLEXIBILITY — down to —65° F.*
6. *LIGHT WEIGHT—15% to 25% lighter than many other synthetic rubbers.*
7. *AGE RESISTANCE—exceptionally resistant to checking or cracking from oxidation.*
8. *HARDNESS RANGE—compounds can be varied from extremely soft to bone hard.*
9. *NON-ADHERENT TO METAL—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)*

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B. F. Goodrich Chemical Company
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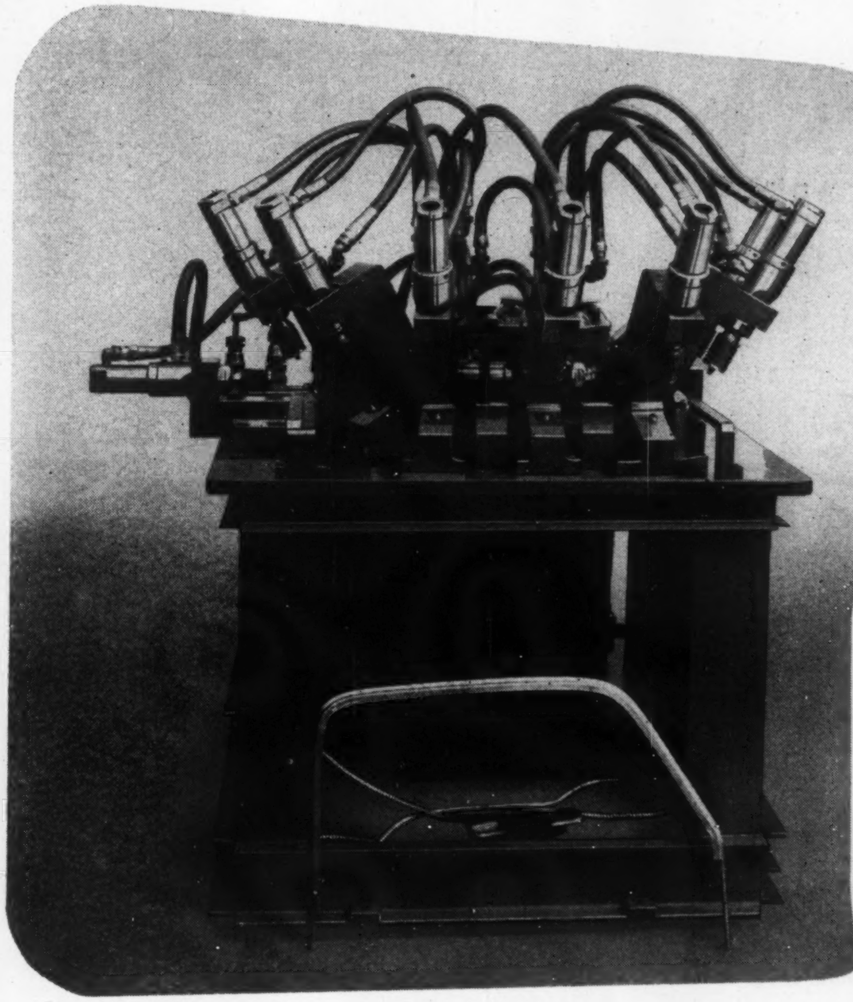
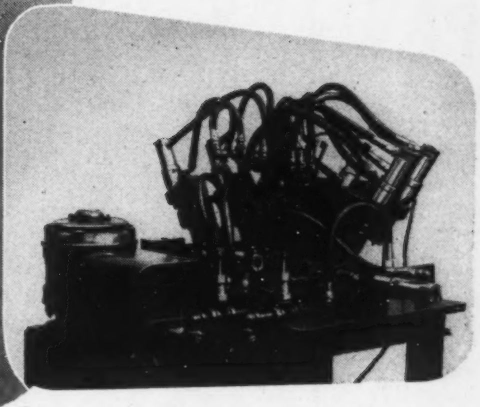


Hydraulic Unit

PIERCES 10 HOLES

at different angles in one operation



AUTO BUILDERS ALWAYS FIND A WAY

of doing jobs better, faster and at lower cost!

THAT'S HOW IT WAS with the job of piercing ten holes at various angles and locations in this automobile door member.

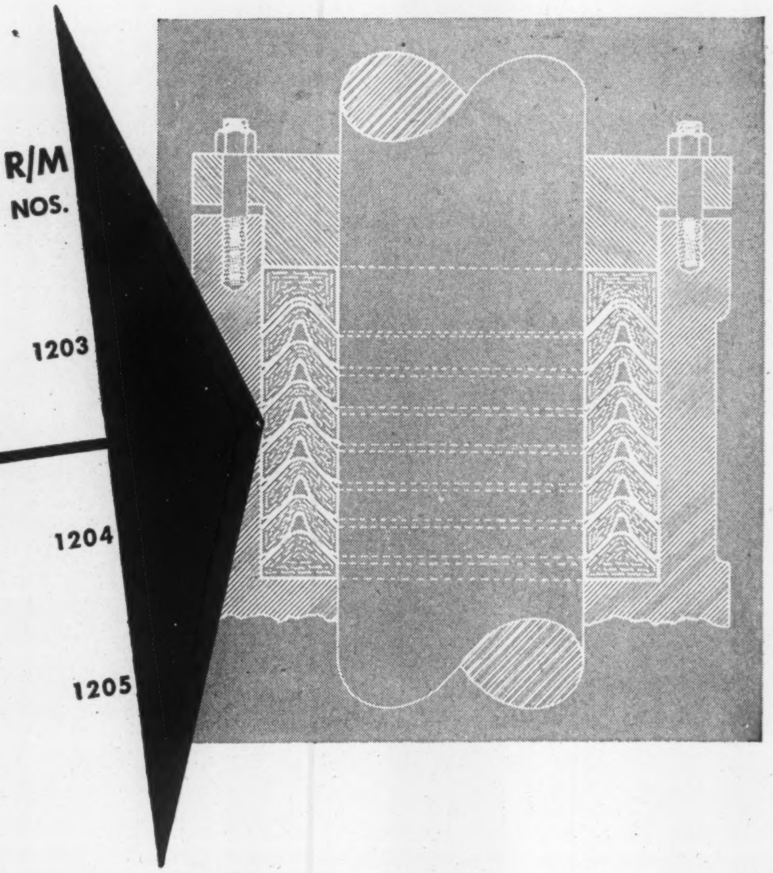
To do the job with a cam-driven die and conventional press would have been laborious and costly . . . a better, faster and low cost way was sought, and the result was

This Barth-built, self-contained, hydraulic pressure piercing unit which pierces all ten holes in one operation through the medium of cylinders located in horizontal position to various angles approaching the vertical. A remote control valve pedal governs the operating cycle which releases a smooth flow of hydraulic power through all 10 cylinders concurrently.

IS YOUR PLANT KEEPING ABREAST of current machine advances . . . of new developments in mechanical, pneumatic and hydraulic operations . . . advantages obtainable through electronic controls? Barth experience and skill in these fields can help you. Write for catalogue.

BARTH STAMPING & MACHINE WORKS Inc.
Denison at W. 34th St., Cleveland 9, Ohio

DESIGNERS AND BUILDERS OF DIES, TOOLS AND SPECIAL MACHINERY



R/M'S VEE-FLEX PACKING RINGS

The Vee-Flex packing ring, developed by Raybestos-Manhattan, is one of the most efficient designs in modern packing, a design that provides maximum sealing ability with simple finger-tightening.

Finger-tightening is all that is necessary because each Vee-Flex ring is so constructed that pressure of liquid or vapor expands the lips circumferentially. Thus the creation of a tight seal is automatic and a function of pressure. By using several rings in a set, a multiple seal of high efficiency is created.

When pressure is released, the tension of the Vee-Flex ring is automatically relaxed, thus reducing frictional wear.

R/M Vee-Flex rings are recommended for use on reciprocating and rotary shafts and for use with steam, oil, food products, chemicals, air, natural gas and other fluids and gases. A large variety of sizes is available.

Actual use over many years has shown that Vee-Flex rings provide a reliable, long-lived seal for pumps, engines, hydraulic cylinders, rams, lifts, and other equipment.

Specify R/M Vee-Flex rings on your blueprints, and put them in your bill of materials. R/M engineers will be glad to discuss the application of Vee-Flex or other types of packings to present equipment or for new designs now on the drafting boards. R/M makes a complete line of modern packings for every industrial use. Write for the compact R/M catalog, and for special Vee-Flex folder.

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R M
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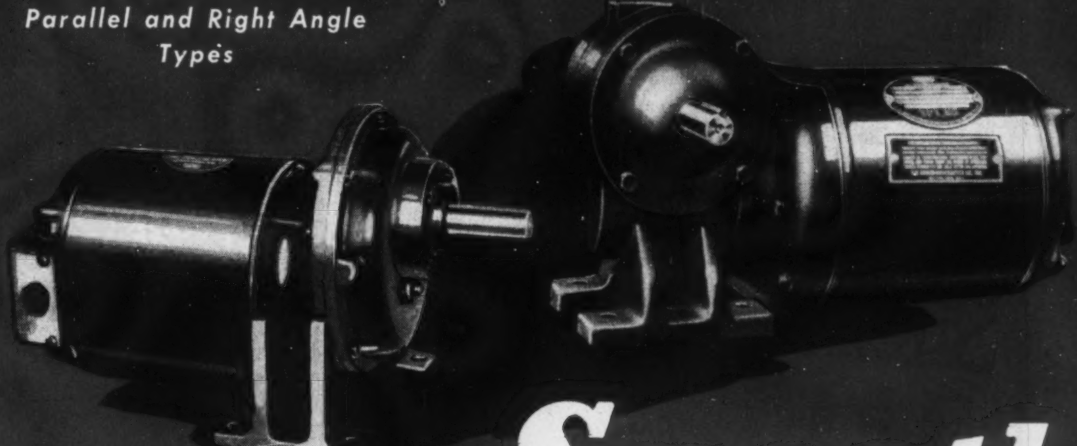
OR SPECIAL RATIOS
Parallel and Right Angle Types



Smooth
PERFORMANCE

Do you use Gearmotors? Perhaps you have been handicapped in getting deliveries, if so, try B-LINE. Remember, "it's good to have a second string to your bow". You will be pleased with their "Smooth Operation".—Write for special bulletin No. 5000 on Motors and Gearmotors.

DEPENDABILITY LONG LIFE ECONOMY B LINE

THE BROWN-BROCKMEYER COMPANY

PLANTS AT DAYTON, WILMINGTON, WASHINGTON AND XENIA, OHIO
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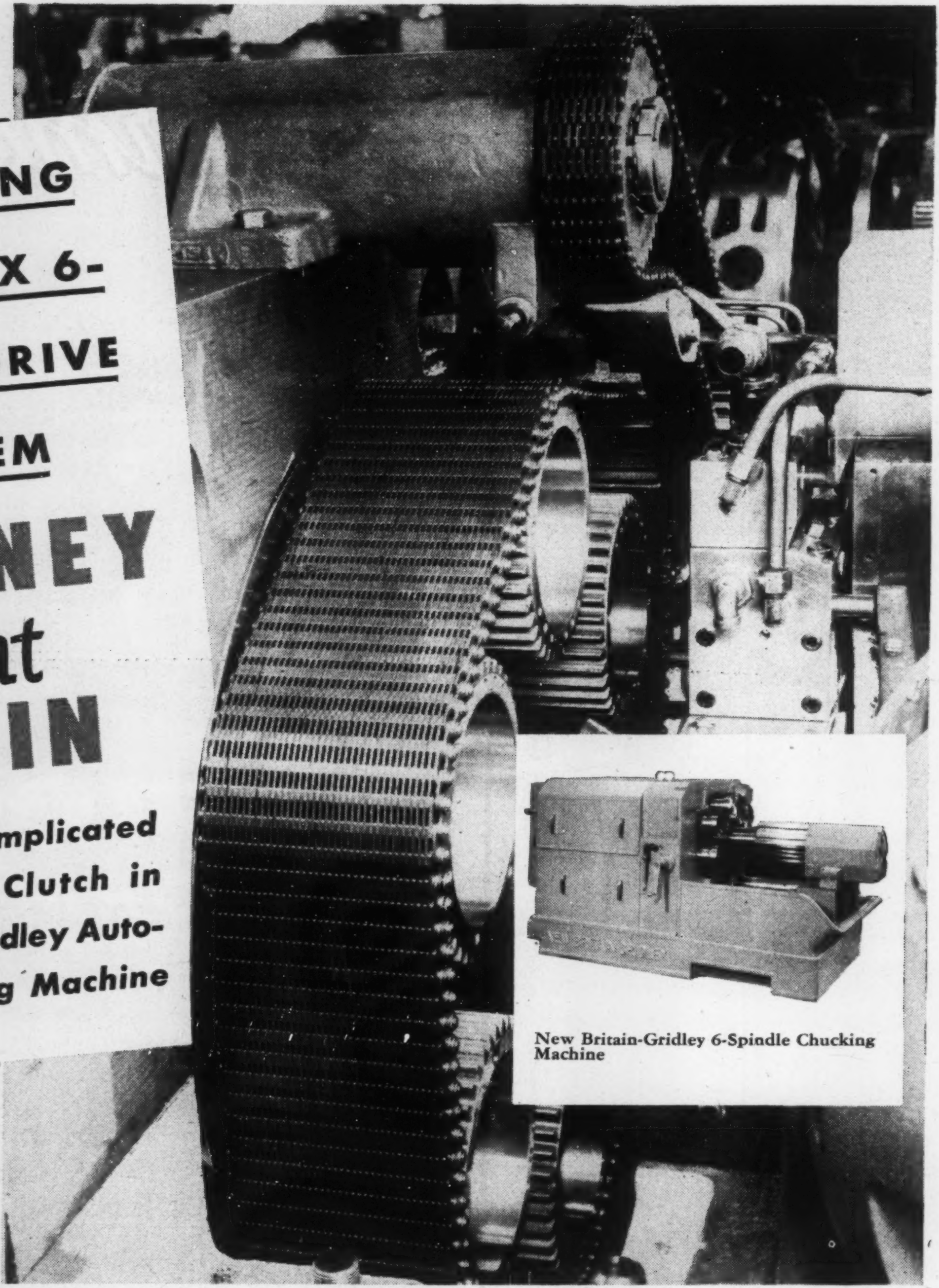
SIMPLIFYING A COMPLEX 6-SPINDLE DRIVE PROBLEM

WHITNEY Silent CHAIN

Eliminates Complicated Gearing and Clutch in New Britain-Gridley Automatic Chucking Machine



New Britain-Gridley 6-Spindle Chucking Machine

Whitney Silent Chain power drive and 6-spindle drive

For positive, uniform spindle speeds, New Britain-Gridley uses Whitney Silent Chain to drive the six spindles in their Model 16 Chucking Machine.

The spindles of this machine are mounted on a circular spindle carrier. Whitney Silent Chain operates on the sprocket portion of the spindles and meshes with each of the spindle drive sprockets. As the spindle carrier indexes, each spindle coming into the loading and unloading station disengages with the chain so the operator may chuck and unchuck the work piece.

After the piece is chucked, the carrier indexes the spindle into #2 position, the sprocket meshes with the continuously operating chain and the spindle begins to drive.

In addition to other advantages, this chain drive design made it possible for New Britain-Gridley engineers to eliminate the need for a clutch to stop the spindle as it indexes into the loading and unloading station.

Designers and builders can improve the performance of their machine tools and other equipment with Whitney chain and cut tooth sprockets. This *all-steel drive* delivers full rated machine capacity, withstands shocks and overloads and cuts maintenance costs. It pays to standardize on Whitney. Write for information, today.

The Whitney Chain & Manufacturing Company

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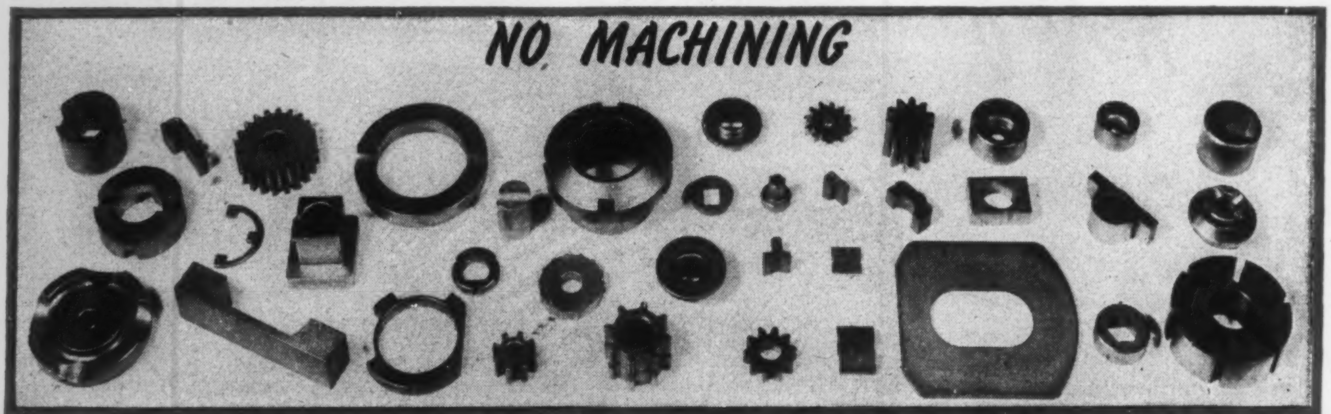
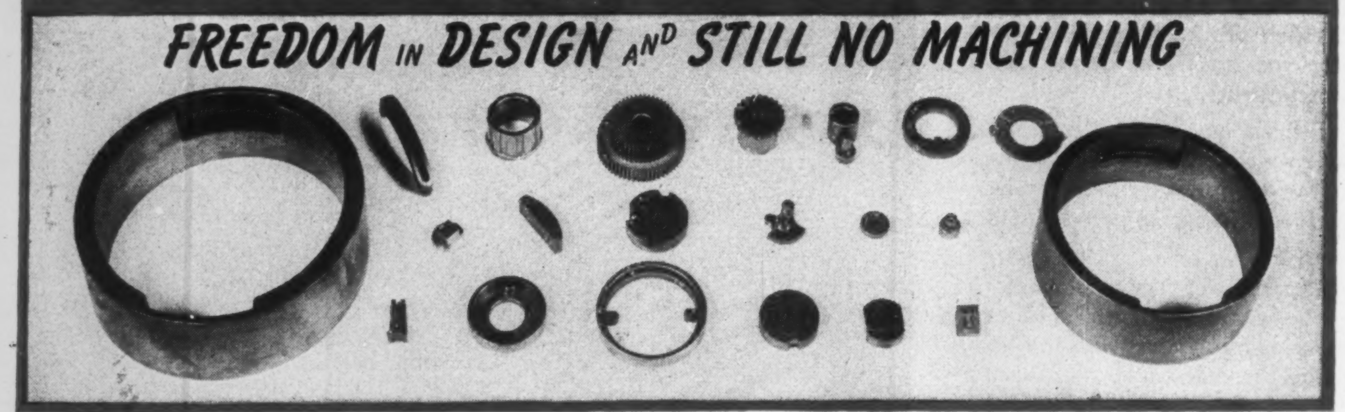
FINISHED-PRECISION

Machine PARTS



NO MACHINING



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YOUR ADVANTAGES INCLUDE . . .

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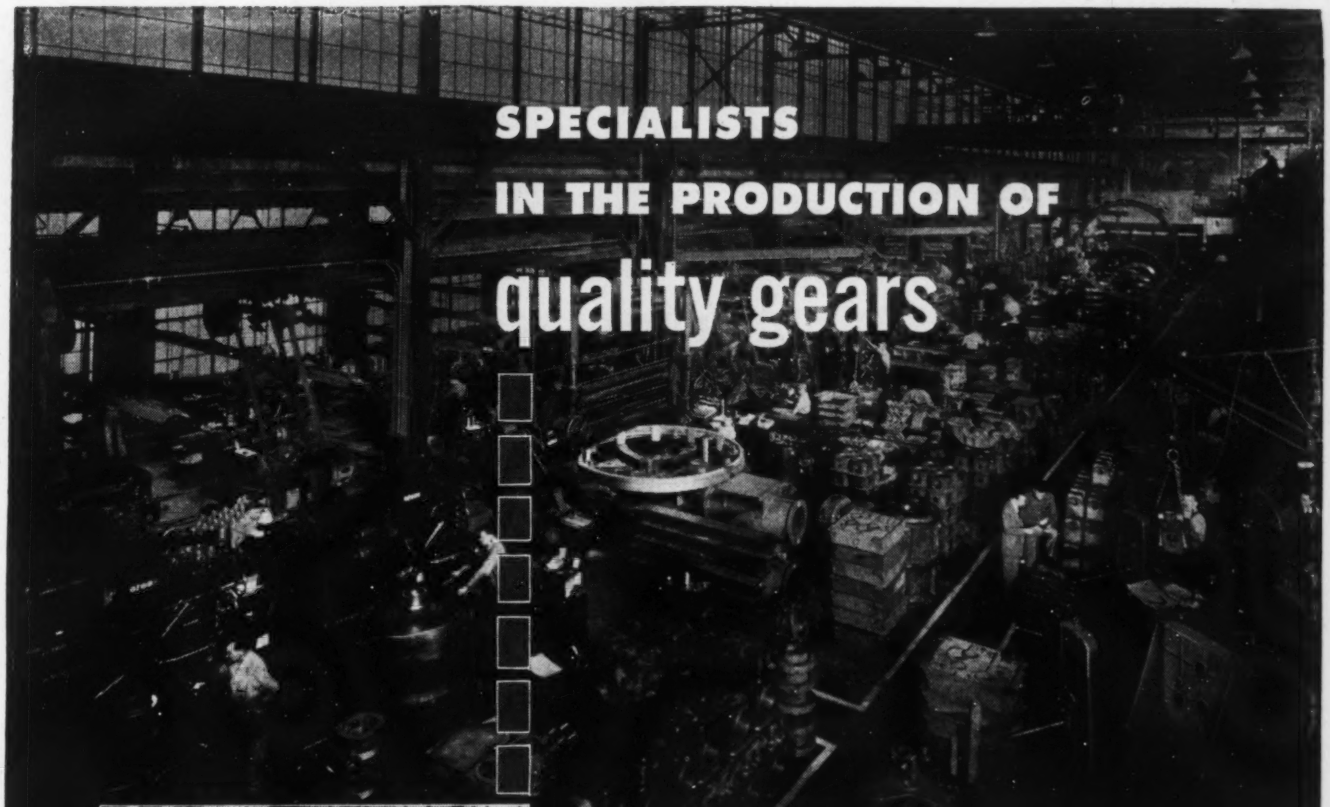
EXPERIENCED STAFF of FIELD and FACTORY ENGINEERS at YOUR SERVICE

CHRYSLER CORPORATION
AMPLEX DIVISION—DETROIT 31, MICHIGAN



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The ability of Foote Bros. to produce the unusual in gears is well known—giants 20 feet in diameter to drive cement kilns or sugar mills—A-Q (aircraft quality) gears of a precision that almost reaches theoretical perfection.

Because of this, many companies overlook the fact that the bulk of Foote Bros.' gear production is in a wide variety of spur, helical, worm and bevel gears. These gears are today serving industry in the production of machine tools, road building machinery, mining machinery, diesel and gasoline engines, tractor transmissions and an extensive list of other types of equipment.

In the two large plants of Foote Bros. you will find everything necessary to produce quality gears of any size and in any quantity—an engineering staff thoroughly experienced in every phase of gear production—the latest in modern high speed machinery—an extensive heat-treating department with controlled atmosphere furnaces, quenching presses, carburizing and nitriding furnaces, and above all a background of nearly a century of experience in meeting and solving the toughest gear problems. We welcome the opportunity of discussing your gear requirements with you.

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Dept. O, 4545 S. Western Blvd. Chicago 9, Ill.

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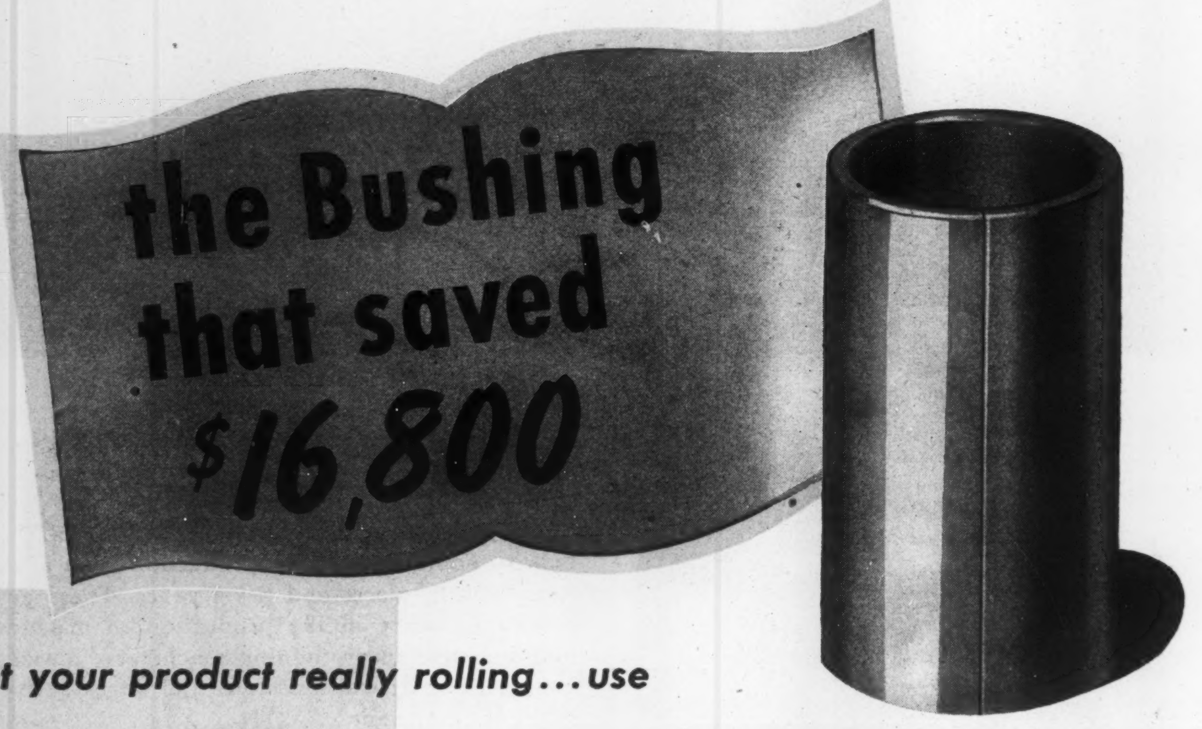
Better Power Transmission Through Better Gears *a typical example of how*

THE FORMETAL IQ* means lower costs to you



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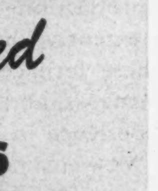
The **Improved Quality* of Formetal "Superformed" Bushings and Bearings gives you better performance at real dollar savings.

For example, an automotive parts manufacturer replaced the ordinary bushings he was using with Formetal Bushings made to his specifications. Now he not only secures better performance, but his savings on bushing costs alone are over $16,800 annually.

The exclusive method by which Formetal Superformed Bushings and Bearings are manufactured gives them qualities that ordinary bushings do not have. They can provide a higher Rockwell hardness without loss of machinability. A thinner wall often will give the same strength as the heavy wall of an ordinary bushing. Custom-made oil grooves, to provide the proper wiping action of the oil film can be engineered to your exact need.

Made of bronze, steel, or an alloy to your specification, FORMETAL bushings or bearings *save you money*. It costs nothing to obtain the data that applies to your product. Write for details and a copy of free reference booklet of BUSHINGS, BEARINGS AND SPACER TUBES... you will find it extremely informative.

National Formetal Co., Inc., 6604 Metta Ave., Cleveland 14, Ohio
Please send free copy of your reference catalog.
Name..
Company..
Product manufactured..
Address..
City and State..



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Manufacturers of "Superformed" Bushings and Bearings... and Spacer Tubes
6604 METTA AVENUE • CLEVELAND 14, OHIO
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• ENGINEERED AND MOLDED AT NO. 1 PLASTICS AVENUE

PROBLEM—
ENGINEER AND MOLD HOUSING FOR CUBE STEAK MACHINE. MUST BE DURABLE, ATTRACTIVE, EASY TO CLEAN.
CUBE STEAK

Have you a steak in plastics?

• Here's a case where plastics contribute to good eating—by forming an attractive, resistant, easy-to-clean housing for this new cube steak machine. It was engineered and molded by General Electric for the Cube Steak Machine Company, Inc., of Boston, Massachusetts. The gleaming white plastics surface resists the action of meat juices and cleaning agents—stays lustrous and beautiful despite the wear and tear of everyday use.

Are *you* taking full advantage of plastics? Whether you make steak machines, lipsticks, or locomotives, General Electric's *complete* plastics service is equipped to design, engineer, and mold plastics to meet your individual requirements. The world's largest molder of finished plastics products, G. E. works with all types of plastics materials—can recommend without bias the best one for your particular job.

May we send you, free, the full-color booklet, "Problems and Solutions in Plastics"? Just write Plastics Division, Chemical Department, General Electric Co., 1 Plastics Avenue, Pittsfield, Mass.

GENERAL ELECTRIC

CD47-H-12

GENERAL ELECTRIC PLASTICS FACTORIES ARE LOCATED IN DECATUR, ILL., COSHOCTON, OHIO, MERIDEN, CONN., SCRANTON, PA., TAUNTON AND PITTSFIELD, MASS.

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NO. 1 PLASTICS AVENUE—complete plastics service—engineering, design and mold-making. Our own industrial designers and engineers, working together, create plastics parts that are both scientifically sound and good-looking. Our own toolrooms are manned by skilled craftsmen—average precision mold experience, 12 years.

ALL TYPES OF PLASTICS. Facilities for compression, injection, transfer and cold molding ... for both high and low pressure laminating ... for fabricating. And G-E Quality Control—a byword in industry—means as many as 160 inspections and analyses for a single plastic part.

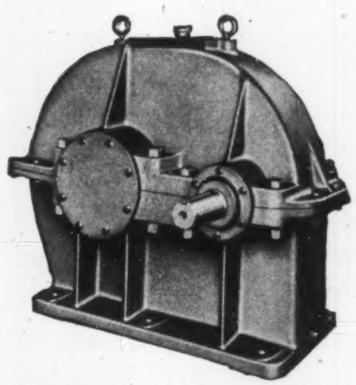
EVERYTHING IN
Plastics

IF YOU'RE NOT THE FIFTH . . .

you'll profit 6 ways from this packaged drive

WESTINGHOUSE

AGMA



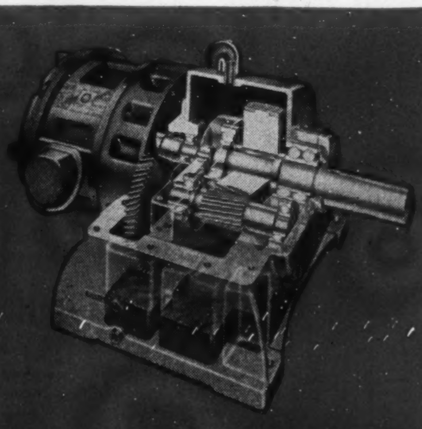
This Type SH speed reducer is a single-reduction unit which is furnished in thirteen standard ratios in each of twelve sizes. The Type DH speed reducer, which is a double-reduction unit, is offered in fifteen standard ratios in each of twelve sizes.

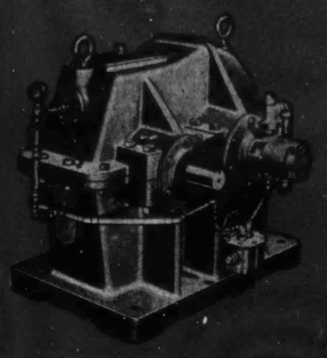
Because 4 out of 5 machines operate at slower speeds than their prime movers supply, you stand to gain six ways when you put Westinghouse speed reducers to work for you:

1. You step up power efficiency (one plant raised it from 80.9% to 85.4%).
2. You reduce frequent servicing of open-type drives to semi-annual lubrication of a packaged unit.
3. Maintain positive alignment of drive and driven machine.
4. Long service life through single helical gearing heat-treated by the exclusive Westinghouse BPT process.
5. Minimum power loss with anti-friction bearings.
6. Precision operation from hob-cut gears.

For drives up to 1,000 hp, you have your choice of twenty-four sizes of Westinghouse speed reducers—Types SH and DH—for speed reduction ratios from 2.82 to 70.5 . . . and you get all the benefits of unit responsibility with motor and gears supplied by one manufacturer.

Get all the facts today from your nearest Westinghouse office on the advantages you'll gain when you use these matched unit drives for all types of speed reduction. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07251





FOR DRIVES FROM 1 TO 75 HP CHOOSE GEARMOTORS

These efficient, economical gearmotors give you the best in modern speed reduction for drives from 1 to 75 hp. Easy to install, simple to service and adaptable for all types of drives and motors. Three types—A, C and E—are available and provide output speeds of 1,450 to 16.5 rpm. All unit types can be used with either single-phase, polyphase or d-c motors.

FOR DRIVES UP TO 2,000 HP AND 9,000 RPM USE THESE SPEED INCREASERS

These matched-unit drives have special advantages for all industrial and commercial high-speed jobs up to 2,000 hp and 9,000 rpm. Units are available in 30 sizes with gear ratios of 1.25 to 3.25 up to 2 to 12.

The whole story of industrial geared drives and the way every industry is using them is told in this new book, profusely illustrated with actual applications. Ask for your copy of B-3730 today, on your business letterhead, please.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

4 out of 5 drives need speed reduction

Better than Ever

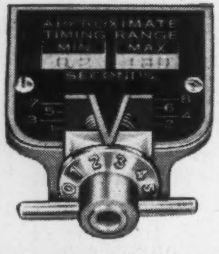
PNEUMATIC TIMER

A.C. and D.C. · **WIDE RANGE**

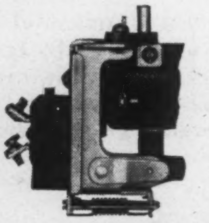
Addition of a heavy-duty, snap-action contact mechanism with isolated N.O. and N.C. Circuits to a dependable timing mechanism makes it perform better than ever, and broadens an already wide range of possible applications.

Features

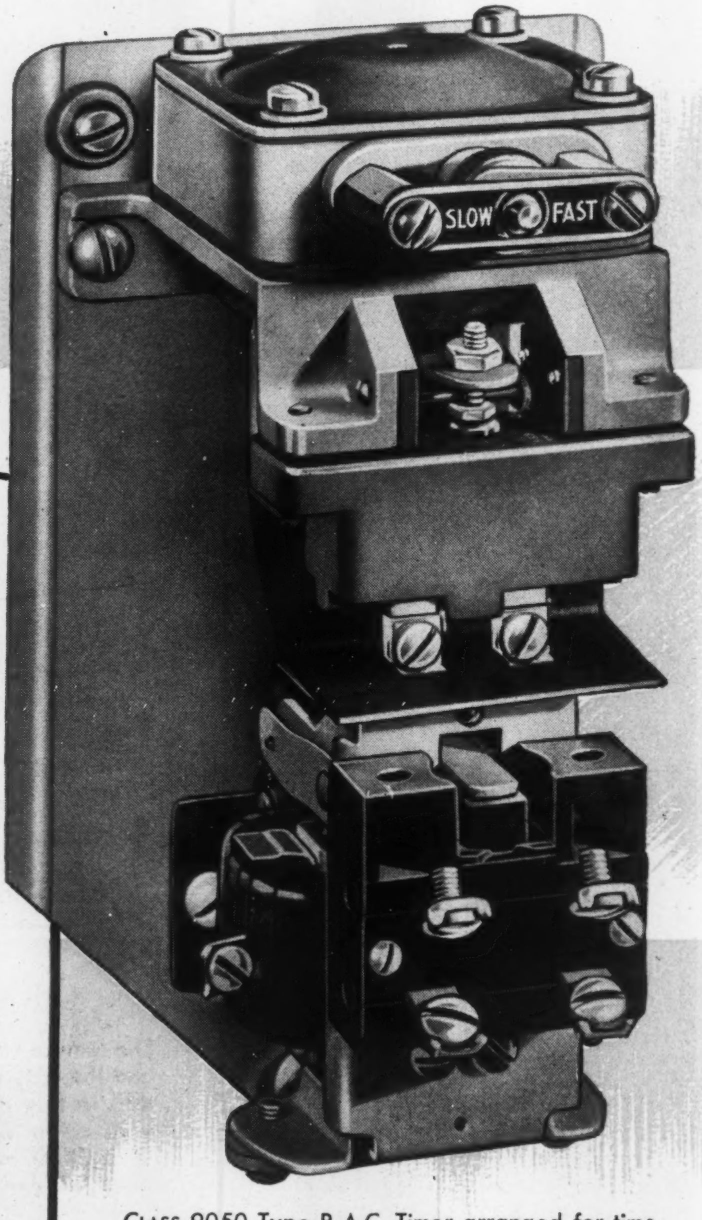
Simple Knob Adjustment



Micrometer Adjustment



Auxiliary Circuits Operated from Magnet



CLASS 9050 Type R A.C. Timer arranged for time delay after energization of actuating magnet

Visit us
at the MACHINE TOOL SHOW
(Chicago)
September 17-26
Booth 678

SQUARE D COMPANY

DETROIT · MILWAUKEE · LOS ANGELES

SQUARE D CANADA, LTD., TORONTO, ONTARIO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

with *New* Contact Mechanism

ACCURATE **FLEXIBLE** **COMPACT** **INEXPENSIVE**

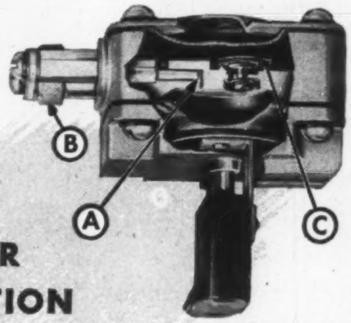
• **For more than ten years** Square D's Pneumatic Timer has been used successfully for timing resistance welds and machine tool sequences, process industry operations and scores of other similar functions. Timing is accurate, easily adjustable, unaffected by shop dust or normal variations in ambient temperature and line voltage.

A.C. and D.C. devices use the same timing principle and have similar mountings. Either can be magnetically actuated or coupled to a magnetic contactor already in the circuit.

Two kinds of operation—time delay after either *energization* or *deenergization* of actuating magnet—provide for circuit simplification and greater dependability.

Adjustment is either by a knurled knob, or a micrometer-type mechanism graduated from 0 to 80. Some types are *individually* calibrated in cycles. Range is from 0.2 seconds to 3 minutes with accuracy better than ±10%.

Auxiliary Circuits operated by the magnet which actuates the timing mechanism, usually eliminate the need for additional switching relays.

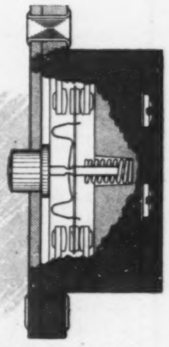


TIMER OPERATION

Simple operating principle is based on the interval required to transfer a small volume of filtered air from upper to lower chamber through a regulated orifice **(A)**. Rotation of knurled knob **(B)** gives wide range of adjustment. Air returns through valve **(C)** for instantaneous reset.

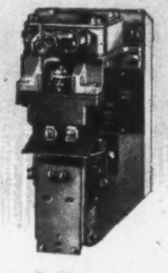
CONTACT MECHANISM

Has separate N.O. and N.C. circuits with double-break, silver contacts . . . Simple operating mechanism uses alloy springs separate from heavy contact blade which carries current . . . Stainless steel compression-return spring . . . Enclosed in a sturdy case of highly arc-resistant melamine . . . Four No. 6-32 binder head terminal screws . . . Electrical ratings are sufficient to directly handle magnet coils of large contactors and some pilot solenoids.

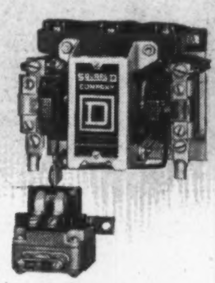


CONTACT RATINGS

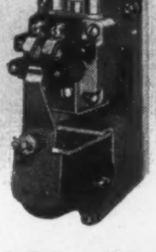
	A. C. Voltage				D. C. Voltage		
Electrical Ratings	110	220	440	550	115	230	550
Normal Amperes	15	10	6	5	0.5	0.25	0.05
Inrush Amperes	40	20	10	8	—	—	—



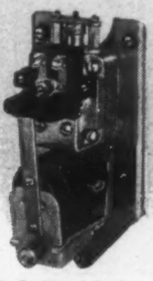
A.C. Time Delay after Deenergization



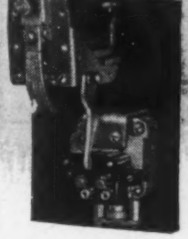
Timer Coupled to A.C. Contactor



D.C. Time Delay after Energization

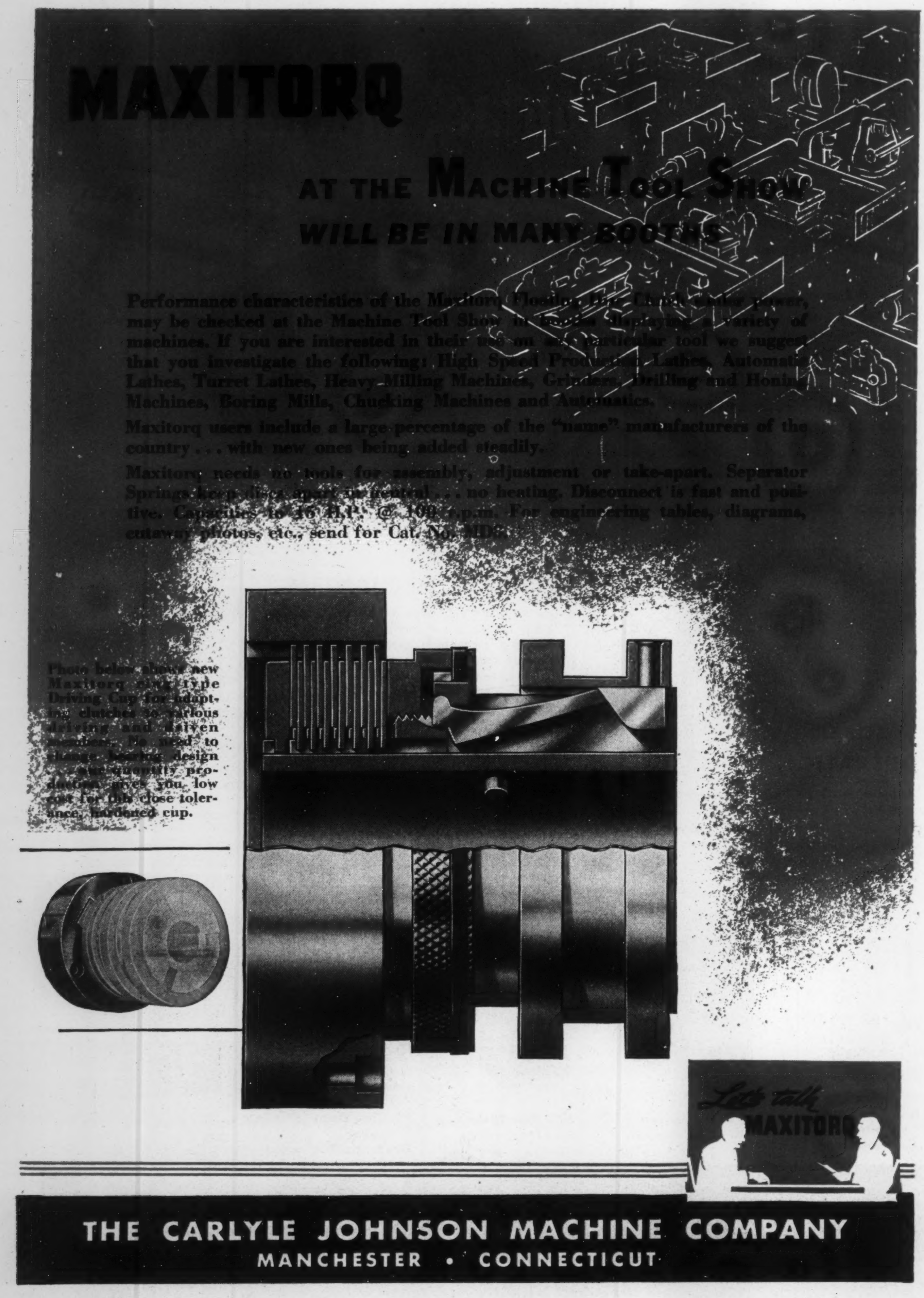


D.C. Time Delay after Deenergization



Timer Coupled to D.C. Contactor

Write **for Pneumatic Timer Bulletin 9050. Address SQUARE D COMPANY, 4041 N. Richards St., Milwaukee 12, Wisconsin.**



MAXITORQ

AT THE MACHINE TOOL SHOW WILL BE IN MANY BOOTHS

Performance characteristics of the Maxitorq Floating Disc Clutch under power, may be checked at the Machine Tool Show in booths displaying a variety of machines. If you are interested in their use on any particular tool we suggest that you investigate the following: High Speed Production Lathes, Automatic Lathes, Turret Lathes, Heavy Milling Machines, Grinders, Drilling and Honing Machines, Boring Mills, Chucking Machines and Automatics.

Maxitorq users include a large percentage of the "name" manufacturers of the country . . . with new ones being added steadily.

Maxitorq needs no tools for assembly, adjustment or take-apart. Separator Springs keep discs apart in neutral . . . no heating. Disconnect is fast and positive. Capacities to 16 H.P. @ 100 r.p.m. For engineering tables, diagrams, cutaway photos, etc., send for Cat. No. MD8.

Photo below shows new Maxitorq ring type Driving Cup for adapting clutches to various driving and driven members. No need to change bearing design . . . our quantity production gives you low cost for this close tolerance, hardened cup.

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

BURKE'S *New Induction Motor*

RESULT OF 41 YEARS INDUCTION MOTOR EXPERIENCE.

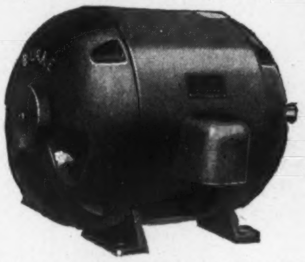
Rotor LAMINATIONS OF HIGH GRADE ELECTRICAL SHEET STEEL, SECURELY KEYED TO SHAFT SPIDER. ROTOR BARS OF HARD DRAWN COPPER STRIP FIRMLY EMBEDDED IN PARTIALLY CLOSED ROTOR SLOTS. EXTENSION OF ROTOR BARS PROVIDES AMPLE FAN ACTION FOR EFFICIENT VENTILATION.

Frame OF ROLLED, WELDED STEEL FOR GREATEST RIGIDITY WITH MINIMUM BULK AND WEIGHT.

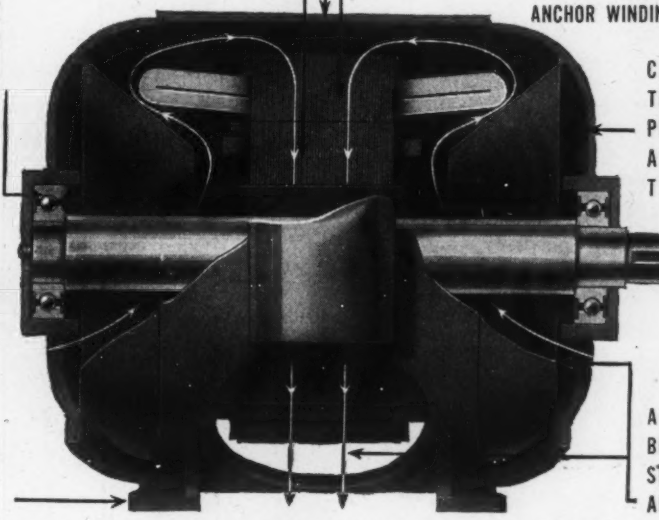
Stator CORE, OF HIGH GRADE ELECTRICAL SHEET STEEL, IS INDEPENDENT OF SUPPORTING FRAME; AND RIGIDLY WELDED INTO PLACE TO MAINTAIN PERFECT ALIGNMENT. STATOR COILS ARE WOUND WITH NEW SYNTHETIC RESIN-COVERED WIRE PROVIDING EXCELLENT DIELECTRIC STRENGTH AND MAXIMUM EFFICIENCY. FIBRE WEDGES SECURELY ANCHOR WINDING IN THOROUGHLY INSULATED SLOTS.

Ball Bearings ARE OF DOUBLE SEAL, PRE-LUBRICATED TYPE. NO FURTHER LUBRICATION NECESSARY DURING NORMAL LIFE OF MOTOR. PRESS FIT ON SHAFT ELIMINATES NEED OF LOCK NUTS AND WASHERS. SLEEVE BEARINGS ALSO AVAILABLE.

CAST ***End Brackets*** WITH INTEGRALLY-CAST BEARING HOUSINGS PROVIDE RIGID SUPPORT FOR ROTOR, ASSURE PROPER SHAFT ALIGNMENT THROUGHOUT LIFE OF MOTOR.



HEAVY, CROSS-WELDED, FORMED STEEL FEET PROVIDE FIRM MOUNTING SUPPORT.



COMPLETE ROTOR IS DYNAMICALLY BALANCED AFTER ASSEMBLY TO GUARANTEE SMOOTH, QUIET OPERATION.

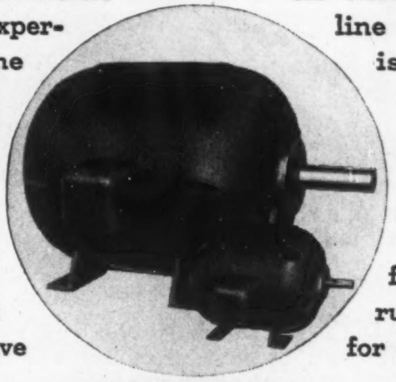
ALL VENTILATING OPENINGS ARE BELOW CENTERLINE. STURDY SHEET STEEL BAFFLE DIRECTS FLOW OF INCOMING AIR FOR MAXIMUM COOLING EFFECT.

CROSS SECTION VIEW OF BURKE TYPE NB INDUCTION MOTOR, FRAME 404

Burke Series "D" NEMA Frame Sizes 203 to 505.

Burke's new line of Drip-Proof Induction Motors follows our traditional policy of designing to generous proportions. We have achieved the utmost from NEMA frame standards utilizing over 30 years experience with welded steel plate frame construction. We have not tried to confine component parts into minimum space. As in all Burke motors we have designed for a generous factor of safety.

These Series "D" Motors on exhaustive tests in our plant have fully justified our generous-proportion-theory —they run exceptionally cool over extended periods of service. Note above that cooling air enters at each end below the centerline induced by rotor fan action, and is deflected up and down and around motor windings leaving thru large side openings between feet and below the centerline—no chance for recirculation. Here ample interior space for air-flow contributes to cool running. Write for bulletin D-1 for complete data.



Uniform in design from NEMA frame sizes 203 to 505.

BURKE ELECTRIC COMPANY 1979 W. 12th ST. ERIE, PA.

UNIVERSAL MOTORS 1/50th to 1½ HP

SINGLE PHASE MOTORS to ⅓ HP

INDUCTION MOTORS 1 to 1500 HP

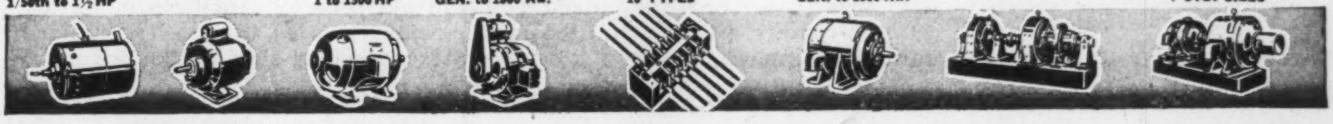
SYNCHRONOUS MOTORS to 1500 HP GEN. to 1000 Kw.

TERMINAL BLOCKS 10 TYPES

D. C. MOTORS to 1500 HP GEN. to 1000 Kw.

M-G SETS to 1000 Kw.

HIGH CYCLE M-G SETS— 7 STD. SIZES



ALLIS-CHALMERS
TEMPERATURE INDICATOR
DEGREES CENTIGRADE
0
10
20
30
40
50
60
70
80
90
100
A-C
AUX.
BATT.
R
GRD.
R
R
L
L
BO.
BO.
L
MARKER
BEACON

QUADRUPLED CAPACITY FOR BETTER SERVICE WITH A BETTER PRODUCT!

FORMICA
TRADE MARK REG. U.S. PAT. OFF.

CAPACITY for sheets, tubes and rods at the Formica factory has been multiplied by four since the war began.

New types of equipment, more efficiently arranged, have prepared the plant for production on a scale never attempted in the laminated industry.

At the same time new types of resinoids and new types of bases have made possible the production of better and more efficient materials better adapted to specific jobs they are expected to perform.

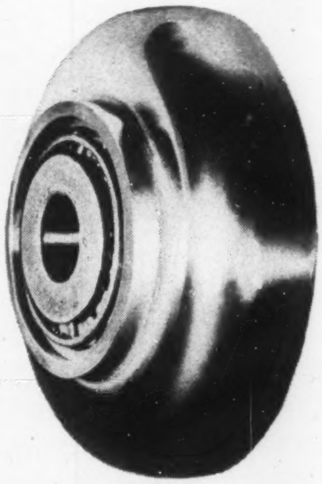
Machining and finishing equipment for electrical parts has been expanded in proportion. So you can send your blueprints here with confidence that when your order is placed you will get promptly, uniform materials of high quality, produced in the most efficient way by the finest manufacturing equipment, manned by the most competent staff in the industry.

THE FORMICA INSULATION CO., 4648 SPRING GROVE AVE., CINCINNATI 32, OHIO

Your machines will last longer

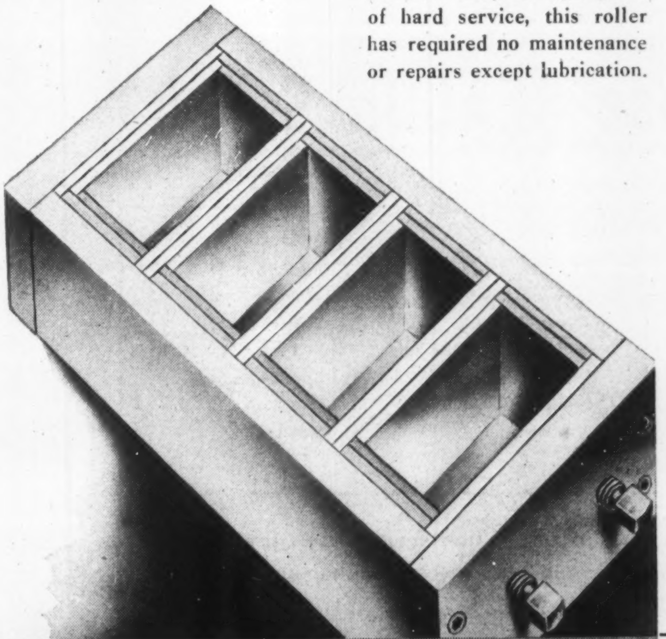
When Vital Parts Are Made of HAYNES STELLITE Alloy

Resists Abrasion—This bushing, made from HAYNES STELLITE alloy No. 6, is used for a ship turbine control mechanism. It resists severe abrasion.



8 Years Service — Burnishing roller made of HAYNES STELLITE alloy. In eight years of hard service, this roller has required no maintenance or repairs except lubrication.

10 Times Longer — HAYNES STELLITE alloy No. 93 brick mold liners, last up to ten times longer than other linings.



Safeguard the vital points of your machinery and equipment by using wearing parts made of HAYNES STELLITE alloy. Parts made of this hard, tough alloy last longer and give more efficient service. This means less down time for replacement and repairs. HAYNES STELLITE alloy stays hard and wear-resistant even when subjected to severe abrasion, erosion, heat, and corrosion.

You can obtain HAYNES STELLITE alloy parts made to your specifications and finished to close tolerances—ready for use. For more information write or phone to our nearest district office!

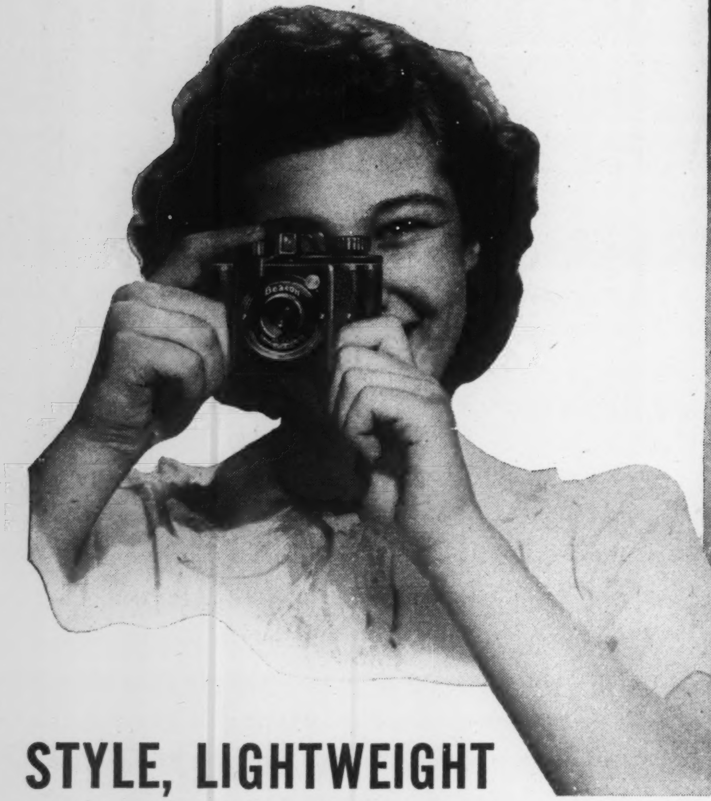
TAKE ADVANTAGE OF THIS
COMBINATION OF PROPERTIES

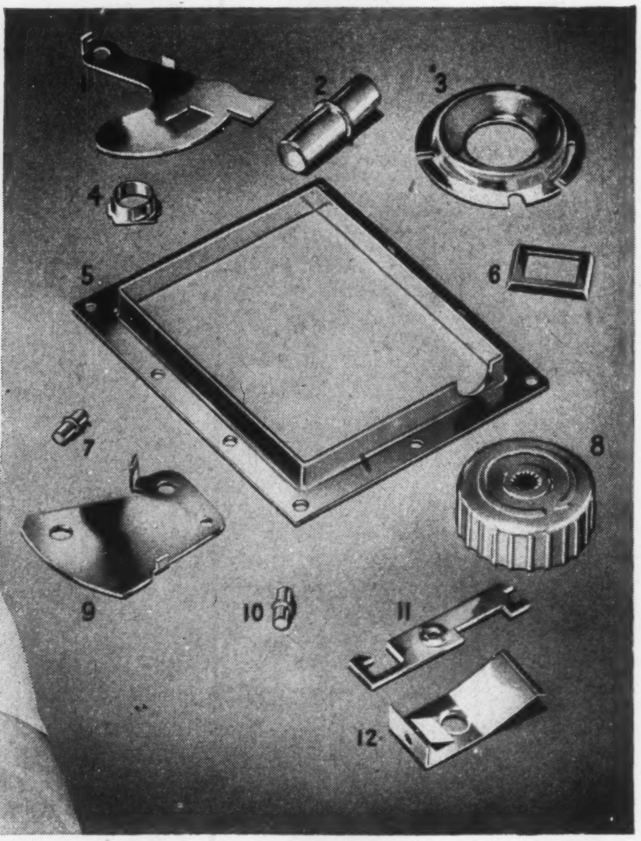
1. HAYNES STELLITE alloy is inherently hard and abrasion-resistant, even at red heat.
2. HAYNES STELLITE alloy is resistant to atmospheric corrosion and many corrosive chemicals.
3. HAYNES STELLITE alloy takes a high polish.
4. HAYNES STELLITE alloy has a low coefficient of friction.

HAYNES
TRADE-MARK
alloys

Haynes Stellite Company
Unit of Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Chicago — Cleveland — Detroit — Houston — Los Angeles — New York — San Francisco — Tulsa

The registered trade-mark "Haynes Stellite" distinguishes a product of Haynes Stellite Company.





STYLE, LIGHTWEIGHT
plus Precision
in the new Whitehouse BEACON Camera

CAMERA ENTHUSIASTS, young and old alike, always expect a lot for a little... so Whitehouse Products, Incorporated, decided that its new Beacon Camera not only should be handsomely styled and light in weight, but also must be made to a high standard of mechanical precision.

The stamped and drawn metal parts used in the camera are shown above. Made in large quantities, to unusually close tolerances in multiple-die production, these parts serve to illustrate our ability to supply precision made stampings and press drawn items in copper, brass, nickel silver and other metals, to exacting requirements and specifications.

Complete engineering services and toolmaking facilities are available, plus the additional advantage of production economies acquired through more than a century of manufacturing experience.

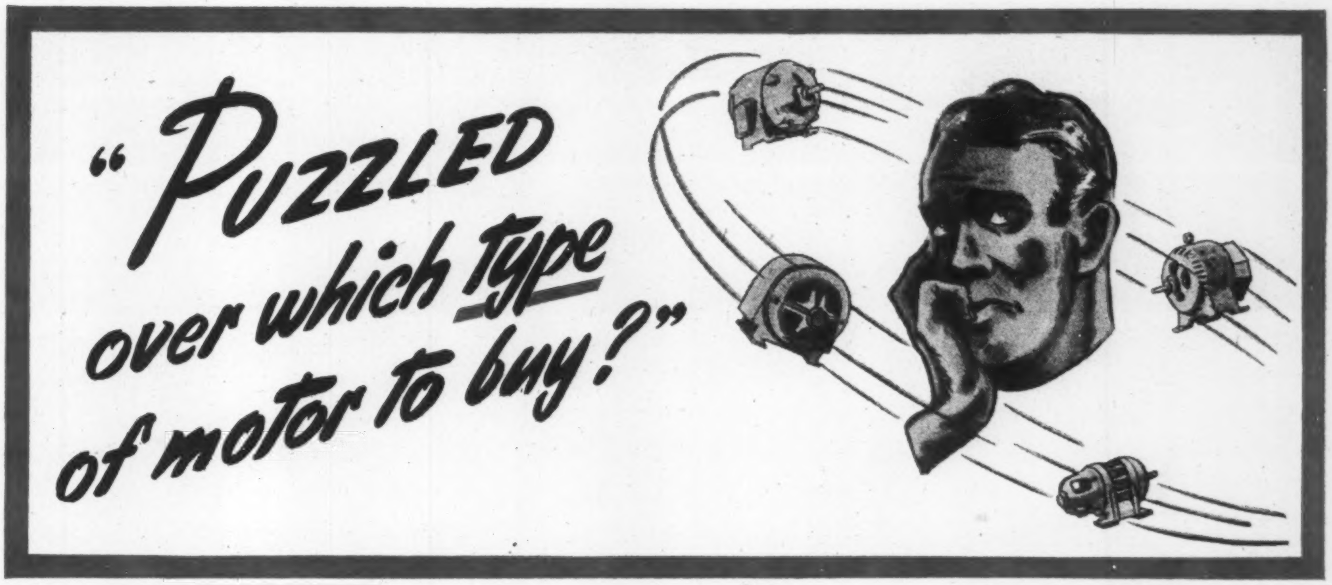
Your inquiry, accompanied by a sample, sketch or description of the part required, together with other pertinent information, will receive our prompt attention. Address your inquiry to: 47427

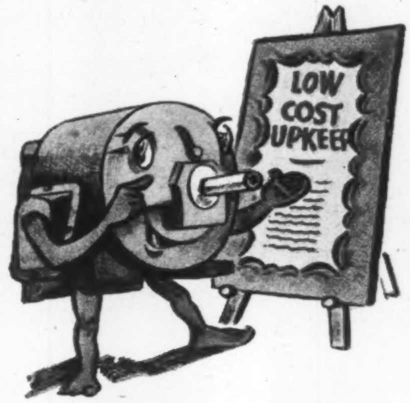
1—Shutter Exposure Leaf
2—Release Button
3—Lens Ferrule
4—Push Button Bracket
5—Front Frame
6—Front Finder Lens Frame
7—Back Catch Stud
8—Winding Knob
9—Shutter Cover Leaf
10—Back Catch Stud
11—Back Catch
12—Side Lock

WATERBURY BRASS GOODS BRANCH
THE AMERICAN BRASS COMPANY
Waterbury 88, Conn.

ANACONDA
from mine to consumer

DEEP DRAWN SHELLS, CUPS, BLANKS, STAMPINGS, EYELETS, FERRULES, GROMMETS, FASTENERS





In 80% of the Cases, open squirrel-cage induction motors meet the need. They fit most drives, and can be obtained in numerous standard and special designs to meet varying conditions of starting torque, slip, etc. They are also the most economical type to buy and to maintain. Allis-Chalmers builds induction motors in sizes from ½ to 10,000 hp — or higher, if needed.

For Tough Starting Conditions, wound-rotor induction motors are recommended. Their high starting torque, at comparatively low starting current, and their controllable speed characteristics are desirable in drives for conveyors, grinding mills and other tough starting assignments. Compact, accessible Allis-Chalmers wound rotor induction motors range in size from 5 to 10,000 hp.

For Slow Speed, direct-connected drives as low as 75 rpm, or other constant speed applications at higher rpm, synchronous motors are a good solution. They are of particular benefit when a system's power factor is low, since they can be furnished for operation at either unity or leading power factor. From 40 hp to 50,000 hp and higher — in bracket bearing, pedestal bearing, or engine types.

D-C CURRENT ONLY

Is d-c Available? Then adjustable speed operation is easily obtainable. Allis-Chalmers builds d-c motors from ½ to 10,000 hp and higher — for constant or adjustable speed duty in ranges of 6:1 and lower. By means of a source of d-c voltage, adjustable speed motors may also be designed to operate over a speed range as high as 30:1. Suitable for fans, elevators, etc.

Select from the Complete Allis-Chalmers Line!

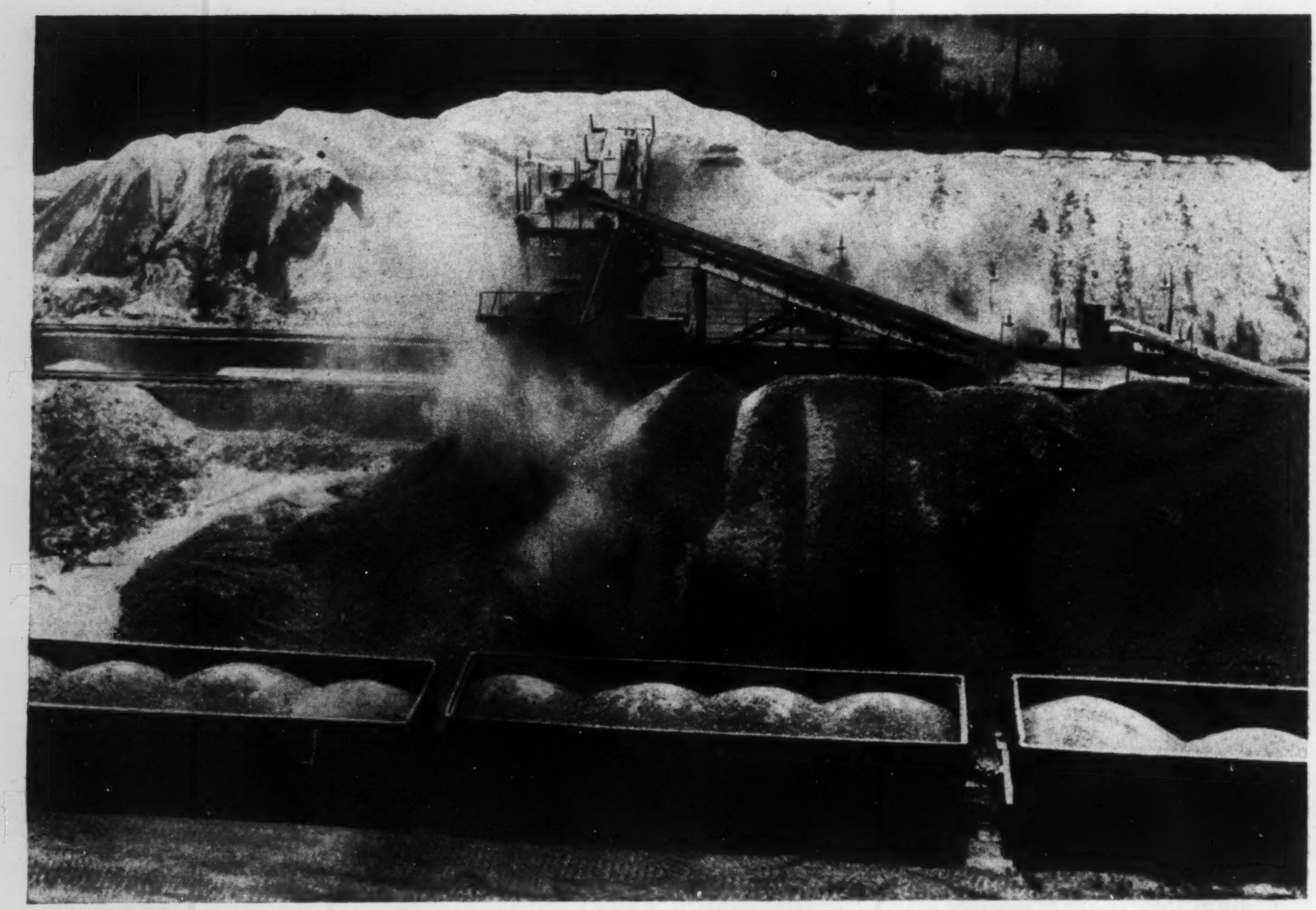
NOT JUST FOLLOWING popular choice and using a standard squirrel cage induction motor. But the *right* motor for economy and efficiency.

That means an overall knowledge of *all* types of motors . . . their operation . . . limitations . . . maintenance. And there's where your A-C representative can be a big help. His recommendations are backed by experience . . . and the Allis-Chalmers motor he selects is *itself* backed by 50 years of experience in motor design and building. ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 2304

1847 1947
A CENTURY OF SERVICE
to Industry
THAT MADE America Great

ALLIS-CHALMERS

**One of the Big 3 in Electric Power Equipment-
Biggest of All in Range of Industrial Products**



1. Bauxite from South American deposits is unloaded and stockpiled at the Baton Rouge plant of The Permanente Metals Corporation, where it is converted to *alumina.* The plant, located on the Mississippi River, comprises 34 buildings on a 318-acre river site, is capable of turning out one billion pounds of alumina per year. It requires four pounds of bauxite ore to make two pounds of alumina.

KAISER ALUMINUM

FROM ALUMINA TO FINISHED ROLLING, PERMANENTE METALS CONTROLS EVERY STEP IN THE PRODUCTION OF KAISER ALUMINUM, ASSURING QUALITY PIG, INGOT, PLATE, SHEET, STRIP, AND ROOFING.

It's something of an achievement to turn out, in a single year, almost as much aluminum as the entire industry produced in the most productive year before the war.

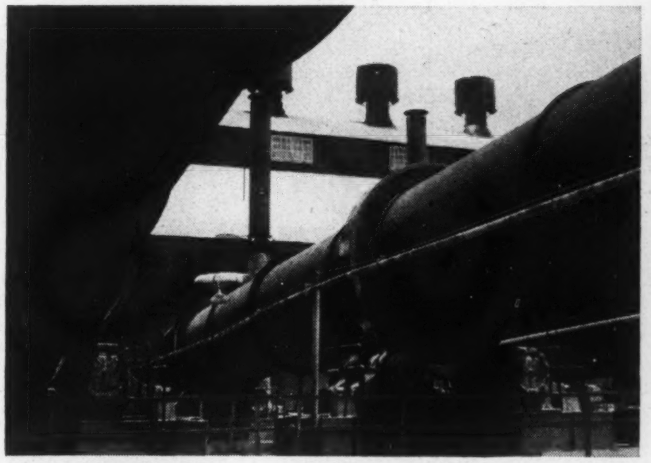
It's even more of an achievement to gain a reputation for quality and service at the same time. One reason The Permanente Metals Corporation has gained this reputation is its integrated operation—from alumina to the finished product.

The story here takes you from the delivery of bauxite at Baton Rouge to the rolling of finished aluminum at Permanente Metals' Spokane mill, with capacity of 288 million pounds yearly.

But no pictures and text can convey to you the eagerness of this young-minded organization to serve the buyers of aluminum . . . to tackle the toughest problems . . . to take its place as a vital factor in this age of light metals.

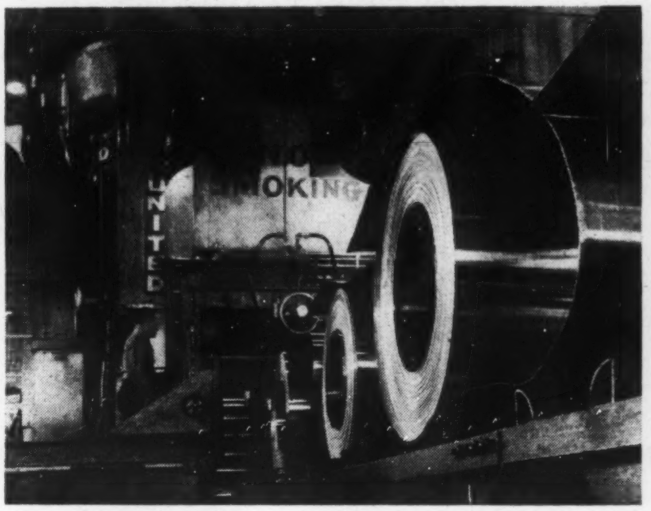
Kaiser Aluminum is a product second to none—not merely as a *substitute* for other metals and materials, but as their *successor* in the scores of applications where aluminum can add something new: lightness, strength, workability, resistance to corrosion, beauty.

And this aluminum is here *today*—ready to meet your requirements!



2. It isn't alumina yet—but this view in the Baton Rouge plant shows the final step in processing. These giant rotary kilns operate at 1800 degrees F, and cook the alumina hydrate into snow-white alumina powder. This alumina is then loaded into box cars and goes by rail to Permanente Metals' reduction plants at Spokane and Tacoma, Washington, where it is converted into basic aluminum.

3. Spokane, Washington, is the home of the reduction plant of The Permanente Metals Corporation, where alumina is made into basic aluminum. Another reduction plant, at Tacoma, increases the supply needed to keep the Spokane rolling mill operating at capacity. Reduction process requires tremendous power. Metal is cast into pure aluminum pigs, then sent to rolling mills for remelting and alloying.



4. The rolling mill at Spokane is capable of producing more than 288 million pounds of aluminum yearly. Two-ton ingots of alloyed aluminum are hot-rolled into long strips. Cut into sheets, the metal is cold-rolled to proper specifications (above). Careful handling and constant testing assure outstanding quality. This plant comprises 53 acres. Plate, sheet and strip are loaded directly into cars for shipping.

5. Here's why Kaiser Aluminum is in demand: Permanente Metals' representatives really give service. Delivery promises are kept. Quality exceeds specifications. Top technical brains are always at your service, may cut your costs through sound advice. Though Permanente Metals itself is but one year old, its administrators, engineers and operators have had years of experience in the aluminum industry.

Ready to serve you—*today*...

Kaiser Aluminum

a Permanente Metals product

DISTRIBUTED BY PERMANENTE PRODUCTS COMPANY, KAISER BLDG., OAKLAND, CALIFORNIA... WITH OFFICES IN:
Seattle, Wash. · Oakland, Calif. · Los Angeles, Calif. · Dallas, Texas · Wichita, Kan. · Kansas City, Mo. · St. Louis, Mo. · Atlanta, Ga. · Minneapolis, Minn. · Milwaukee, Wis.
Chicago, Ill. · Cincinnati, Ohio · Cleveland, Ohio · Detroit, Mich. · Boston, Mass. · Hartford, Conn. · Buffalo, N.Y. · New York City, N.Y. · Philadelphia, Pa. · Washington, D.C.

RMAL
OFF
HIGH
DICTOGRAPH

Molder:
Bridgeport Molded Products, Inc.

The Cabinet speaks . . . for itself!

One look at the Dictograph Intercom—and you're already half sold. *You want it on your desk.*

The *cabinet* can take most of the credit for this. High styling went into its design. And you can see at a glance that a good share of its attractiveness lies in the material chosen for its mass-manufacture —sleek, black BAKELITE phenolic plastic!

What you *can't* see is the 40% saving in cost that also resulted from this altogether happy choice!

BAKELITE phenolic plastic molding compounds often yield a "double return" of this nature—not only costing less but doing a better all-round job. Such materials can be heat-resistant —or high in dielectric strength if need be. Depending on their formulation, they are resistant to chemicals—abrasion—impact. They hold their color and retain any finish the mold imparts—a rich gloss, handsome sheen, stippled or satin effects . . . whatever you require. They are easily molded, by standard techniques.

How can *you* use BAKELITE phenolic molding materials? Write Department 16 for information on the many types available.

TRADE-MARKS

BAKELITE
PLASTICS

The Most Important Production Question of Today:

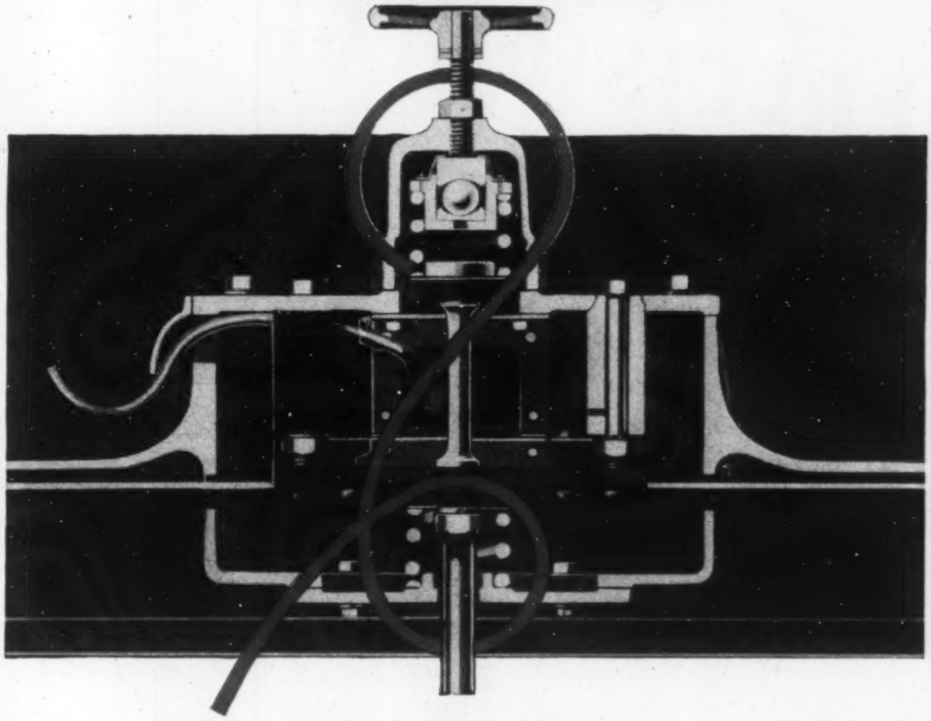
"How can you do it better . . . and cut costs?"

Bakelite Corporation may suggest an answer—through use of plastics.

BAKELITE CORPORATION, *Unit of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.Y.

YEAR IN-YEAR OUT

1800 to 3600 Vibrations a minute!



The Hum-Mer Screen, made by the W. S. Tyler Company of Cleveland, Ohio, successfully screens everything from explosives to women's face powder. Its screen mechanism vibrates 30 to 60 times a second. Two of the important springs in this machine are U·S·S American Quality Springs . . . and even under this severe punishment, they last years without replacement.

That calls for quality springs!

● 1800 to 3600 vibrations a minute is a real test for any spring. Yet in the electrically vibrated mechanism of this screening machine, U·S·S American Quality Springs last years without replacement!

Under equally severe conditions, precision-made American Springs manufactured to close tolerances are giving faithful, economical performance in hundreds of other applications.

These springs are constantly being improved to keep pace with the increasingly severe demands made on them by today's machine developments. Our staff keeps abreast of all metallurgical advances, of every improvement in spring steel . . . and incorporates them without delay in U·S·S American Spring design.

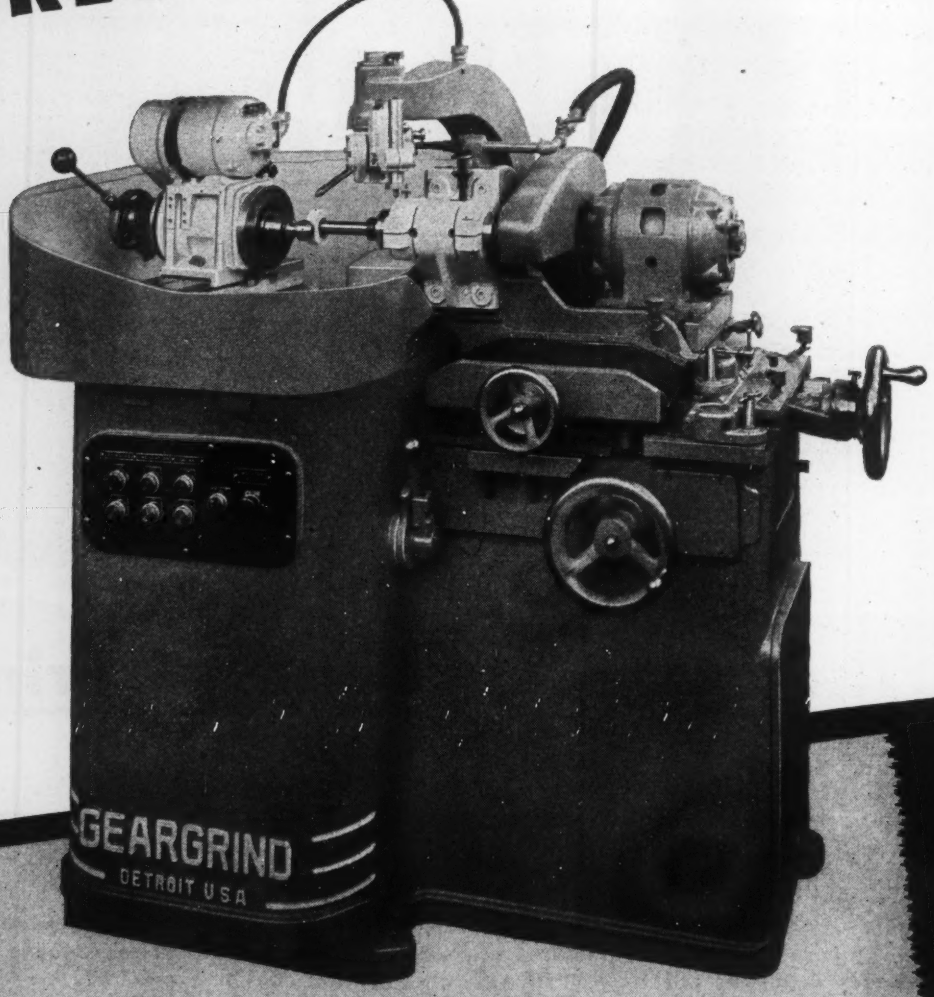
Bring your spring problem to us, whether you buy your springs ready-made or make them yourself. Our experts will see to it that you are supplied either with exactly the right springs for your job, or with the best spring wire obtainable for making your own springs.

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York
Columbia Steel Company, San Francisco,
Pacific Coast Distributors
Tennessee Coal, Iron & Railroad Company, Birmingham,
Southern Distributors
United States Steel Export Company, New York
UNITED STATES STEEL

AMERICAN STEEL & WIRE COMPANY
USS
AMERICAN SPRINGS
UNITED STATES STEEL

U·S·S American Quality Springs

Here's the NEW GEARGRIND UNIVERSAL OSCILLATING PRECISION GRINDER



You will see this new grinder at work when you visit the Machine Tool Show in Chicago. It handles external and internal cylindrical surfaces, internal tapers and external conical surfaces, generated or formed spherical external and internal surfaces as well as generated or formed annular surfaces such as ball bearing races and fillets.

You can also grind combinations of the above in one set-up—certain of extreme accuracy and a perfect blending of straight and curved surfaces.

If you wish full information prior to the show we shall be glad to send illustrated literature and complete specifications upon request.

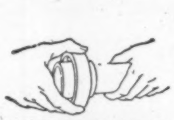
The **GEAR GRINDING MACHINE COMPANY**
DETROIT 11, MICH., U.S.A.

See it at the
MACHINE TOOL SHOW
Booth 670

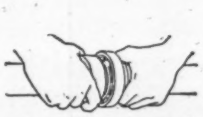
DOUBLE RING *Wedding*

INSTEAD of orange blossoms, matching eccentric cams. That's how these two rings "wed" a Fafnir Ball Bearing to any standard size shaft . . . without shouldering, threading, lock nuts or adapter devices. It's the self-locking collar feature of the famous Fafnir Wide Inner Ring Ball Bearing . . . the Fafnir development that ended years of unnecessary bearing cost and complications.

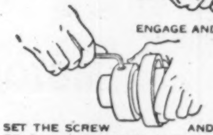
Industries, hobbled with plain bearing equipped machinery, were able to change over to ball bearings . . . at a time cost of only a few minutes per bearing and no cost for machining or new shafting. And new machines featured these Fafnir Wide Inner Ring Bearings that can be removed as easily as they are installed.



SLIP IT OVER THE SHAFT



ENGAGE AND TURN THE COLLAR



SET THE SCREW AND THE BEARING IS SECURED TO THE SHAFT

Nothing could be simpler. The bearing slip-fits right onto the shaft. A quarter turn of the collar engages the eccentric cam with the matching cam of the extended inner ring, locks collar, bearing and shaft in a binding grip. As additional precaution, a set-screw in the collar is tightened to give a wedging action that is proof positive against shock or reversing loads. This Fafnir Wide Inner Ring Bearing is available in a full range of inch shaft dimensions for use in users' own housings and in a complete line of power transmission units . . . pillow blocks, hanger boxes, blower boxes and cartridges.

It's so simple, so sensible that you're sure to say the usual "Why didn't someone think of that before?" The answer, of course, is that thinking of simple, sensible ways to improve ball bearings is just the job Fafnir is set up to do. The Fafnir Bearing Company, New Britain, Connecticut.

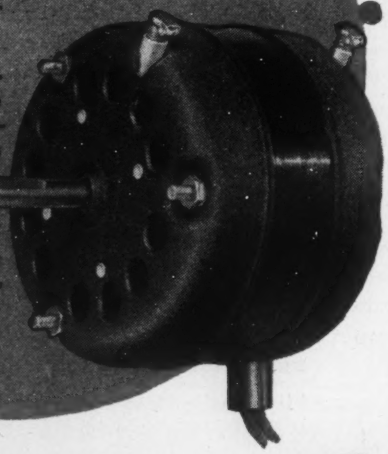
FAFNIR BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

DRIVE YOUR PRODUCTS to market with alliance MOTORS

THE NEW MODEL A shaded pole, induction-type Alliance Fan Motor for speeds from 500 to 1050 R.P.M. operates on 50 or 60 cycles at voltages up to 220, 1/30th horsepower, size 4⅝ x 2¾ inches. Porous bronze, oilless-type sleeve bearings. Open or fully enclosed construction. Approx. 8 to 40 oz. in. full load running torque, depending on stack length. Exceptionally quiet. For continuous or intermittent duty. Runs clockwise or counter clockwise — not reversible.

OTHER ALLIANCE POWR-PAKT MOTORS in shaded pole induction and split-phase reversible resistor types rated from less than 1/400th h.p. on up to 1/20th h.p. for powering valves, switches, controls, driving turntables, fans, record changers and automatic devices.



SLOWER SPEEDS • LOWER CURRENT COSTS
QUIETER OPERATION • SMALLER SIZE

Here are four *big* advantages built into the new *Alliance Powr-Pakt* fan motors. Results are longer life — less repair — smoother performance. This new Alliance shaded pole fan motor reflects advanced engineering! Mass-produced at low cost! Write.

WHEN YOU DESIGN — KEEP alliance MOTORS IN MIND

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO

This NEW Veelos Catalog is Crammed with V-Belt Benefits for You

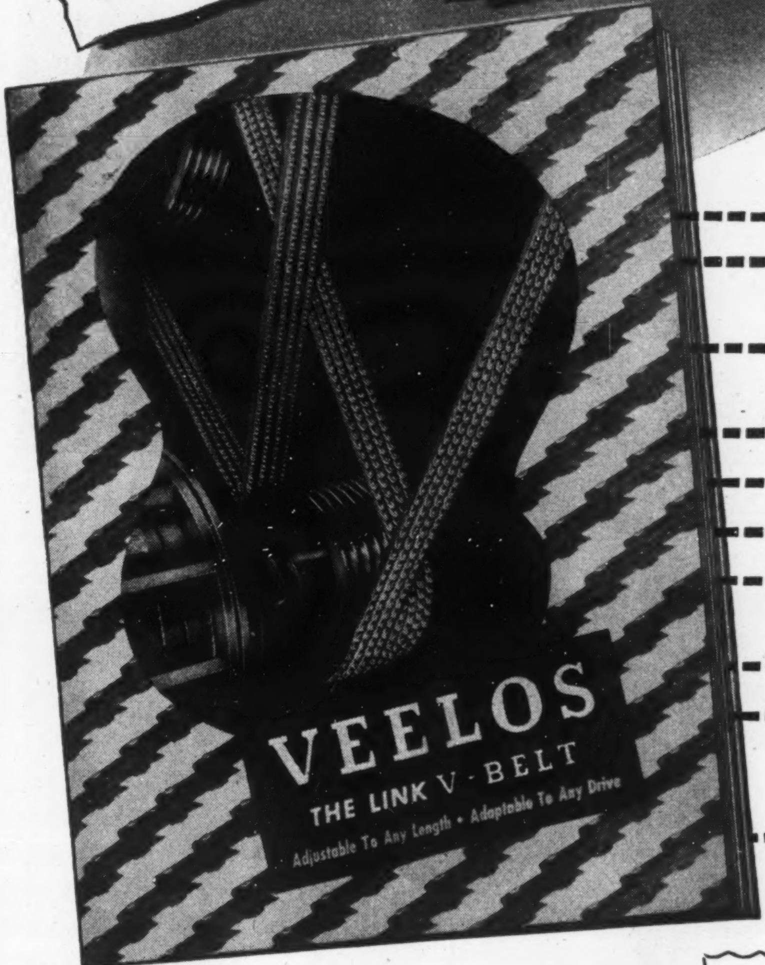
Here are just a few...

Insurance Against Shutdowns
Belt replacements for any length drive are always available from a reel of Veelos.

Expensive Belt Inventories Ended
Four reels of Veelos replace up to 316 sizes of endless V-Belts. Veelos takes up only trifling storage space ... simplifies stock records.

Costs Far Less to Install
Belts are quickly uncoupled, made endless and installed. Installation savings run as high as 9/10 the cost of installing endless belts.

Easy Adjustability
Uniform tension maintained just by removing one or more links. On fixed center drives, slide rails and pivoted motor bases are not needed.



- 14 Important Advantages *(Page 2)*
- Four Reels replace up to 316 Sizes of Endless V-Belts (*Page 3*)
- Two Types Cover All Drive Requirements (*Page 5*)
- Special Applications (*Page 5*)
- Construction (*Page 6*)
- How to Measure (*Pages 7 and 9*)
- How to Couple and Uncouple (*Page 8*)
- How to Install (*Page 9*)
- Engineering Data: Selection and Length Tables, HP Ratings, etc. (*Pages 10 and 11*)
- Installation Photos of Veelos at Work in a Wide Variety of Industries (*Pages 12 to 24*)

Clip Coupon ***for Veelos catalog. The edition is limited but there's a copy for you.***

It's FREE

THIS fact-packed catalog describes in detail 14 distinct advantages of Veelos, the link V-belt. It shows Veelos in action on drives in a wide variety of industries. You will find easy-to-read instructions, applications, installations, engineering data. Send coupon for the book that will bring many benefits to your plant.

MANHEIM MANUFACTURING & BELTING CO.
606 MANBEL ST., MANHEIM, PA.

MANHEIM MANUFACTURING & BELTING CO.
606 MANBEL ST., MANHEIM, PA.

Please send without obligation a copy of your new Veelos catalog.

Name.................................... *Title*......

Company..

Address..

....

Veelos—Known as VeeLink outside the United States

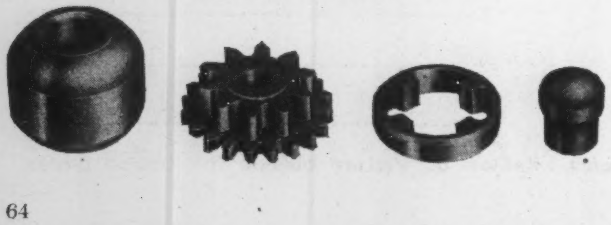
gramix bearings and USG brushes

[illegible]

[illegible] wouldn't be *delighted* with this modern, streamlined Dormeyer Kitchen Mixer . . . especially with its smooth, *trouble-free operation* that comes, in part, from GRAMIX powder metal bearings and USG BRUSHES. GRAMIX self-aligning and sleeve bearings keep the shaft rotating true—require no lubrication—are unaffected by the high shaft speeds. The GRAMIX bearings help to keep Dormeyer *production costs down*, too, because they are made by die-pressing powdered metals to exact size and shape, with perfect bearing surfaces that need no expensive machining or hand finishing. GRAMIX powder metal parts are porous, so that *one impregnation with lubricant* may provide sufficient *lubrication for the life of the installation.* Our engineers will be glad to study sketches of *your* products and show you where GRAMIX bearings, and other machine parts will improve mechanical performance and save you money. *Write today for your copy of the big, new, 260-page* GRAMIX CATALOG.

USG BRUSHES in the Dormeyer Kitchen Mixer provide positive electrical contact, prevent annoying failures and costly service. We manufacture a complete line of carbon-graphite, pure graphite, and metal-graphite brushes *for all types of rotating electrical equipment,* with current carrying capacities ranging from 30 to 150 amperes per sq. in. Our engineering service is available to determine *your* requirements.

gramix bearings
USG brushes

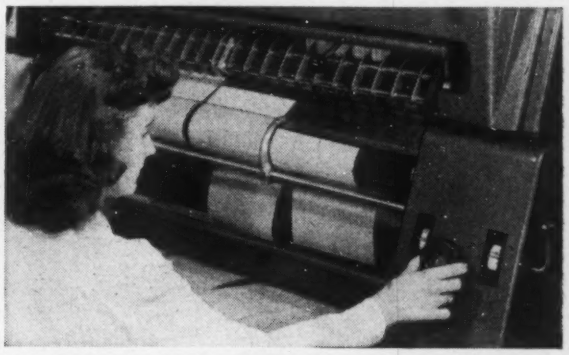


THE UNITED STATES GRAPHITE COMPANY
SAGINAW, MICHIGAN

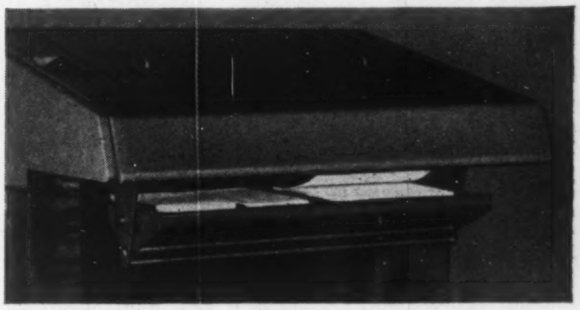
Never before so simple!

No, never before has any large-volume printer-developer offered such *simplicity* in making direct-line process reproductions of your engineering drawings in ink or pencil—office forms—specifications—bulletins, etc. One operator, using this new Bruning Volumatic, can produce prints in seconds from translucent or transparent originals—in unlimited quantities—on cut sheets or roll stock. Compactly designed, the Volumatic can be installed anywhere—requires no plumbing, produces no irritating fumes which must be exhausted. Mail the coupon for complete information.

LARGE VOLUME PRODUCTION is handled with amazing ease on the Bruning Volumatic. The feedboard provides approximately 13 square feet of area for stacking unexposed BW cut sheets and the originals to be reproduced. You can have black or colored line BW paper prints on white backgrounds—light, regular or card-weight BW Prints—black or colored line prints on green or pink tinted backgrounds—cloth prints—transparent paper or film prints!



NO CONFUSING GADGETS on the Volumatic! The few controls necessary are simple in operation and are always within easy reach of the operator. Illustration shows the speed control knob which enables the operator to change instantly to any printing speed from 0 to 30 feet per minute, consistent with the type of original being reproduced. Efficient exposure is provided by a stationary 3450 watt high pressure mercury vapor arc lamp.



READY FOR USE, prints are automatically stacked on a convenient tray at the rear of the Volumatic. When roll stock is used, a simple adjustment of the stacking tray directs printed roll stock to your trimming table. With the Volumatic, you are sure of getting uniformly developed prints at all speeds—easy-to-read direct-line process prints, far more useful than blue prints.

BRUNING

CHARLES BRUNING COMPANY, INC.

Since 1897

NEW YORK • CHICAGO • LOS ANGELES

Atlanta • Boston • Cleveland • Detroit • Houston • Kansas City
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CHARLES BRUNING COMPANY, INC.
4726-40 Montrose Avenue
Chicago 41, Illinois

Gentlemen: I want to know more about Bruning BW Prints and equipment. Please send me information.

Name..

Company..

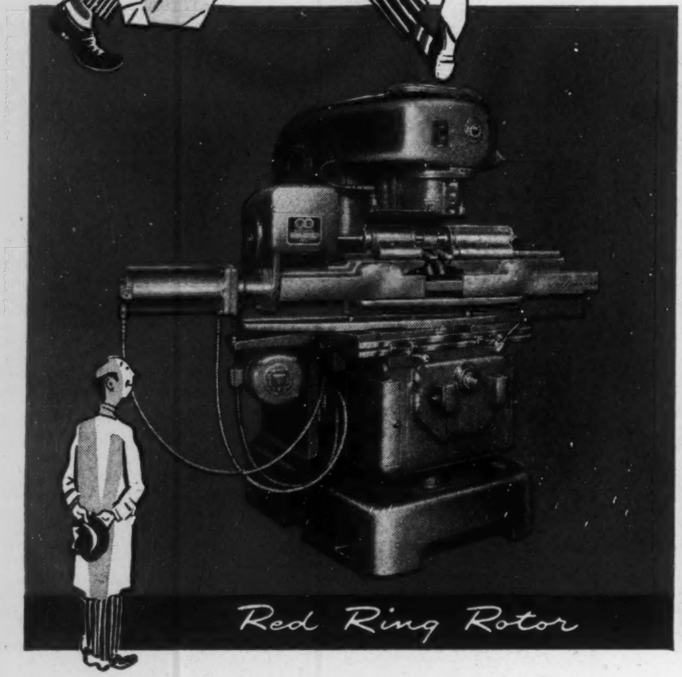
Street..

City.......................... *State*..............

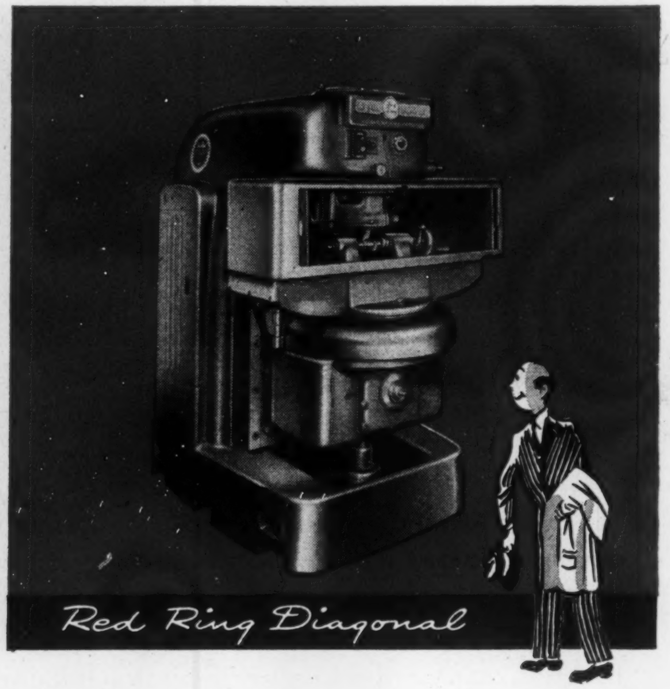
CHICAGO
SEPT. 17-26

Going to the
Machine Tool Show

If you are interested in modern precision gearing, its production and inspection, you will doubtless be interested in the new Red Ring equipment to be exhibited at the Machine Tool Show in Chicago, Sept. 17 to 26.



Red Ring Rotor



Red Ring Diagonal

Featured in this exhibit will be the new Diagonal Gear Shaving Machine, a high production unit which has materially extended the field of gear shaving.

Another feature will be the new Red Ring Rotor Shaving Machine which has been so successful in reducing the cost of finishing the rotor laminations of electric motors.

Included also will be the standard gear shaving machines, a gear lapping machine, gear checking and sound testing machines.

The latest in broaching practice with naloy broaches, broached parts and cutting tools will be there for your inspection.

National Broach engineers will be at BOOTH 607 to explain this equipment and answer your questions. You are cordially invited to stop by.

2709

RED RING PRODUCTS

NATIONAL BROACH AND MACHINE CO.

5600 ST. JEAN • DETROIT 13, MICHIGAN

SPECIALISTS ON SPUR AND HELICAL INVOLUTE GEAR PRACTICE • ORIGINATORS OF ROTARY SHAVING AND ELLIPTOID TOOTH FORMS

In the home "Production Department". . . SUPERIOR STAINLESS serves

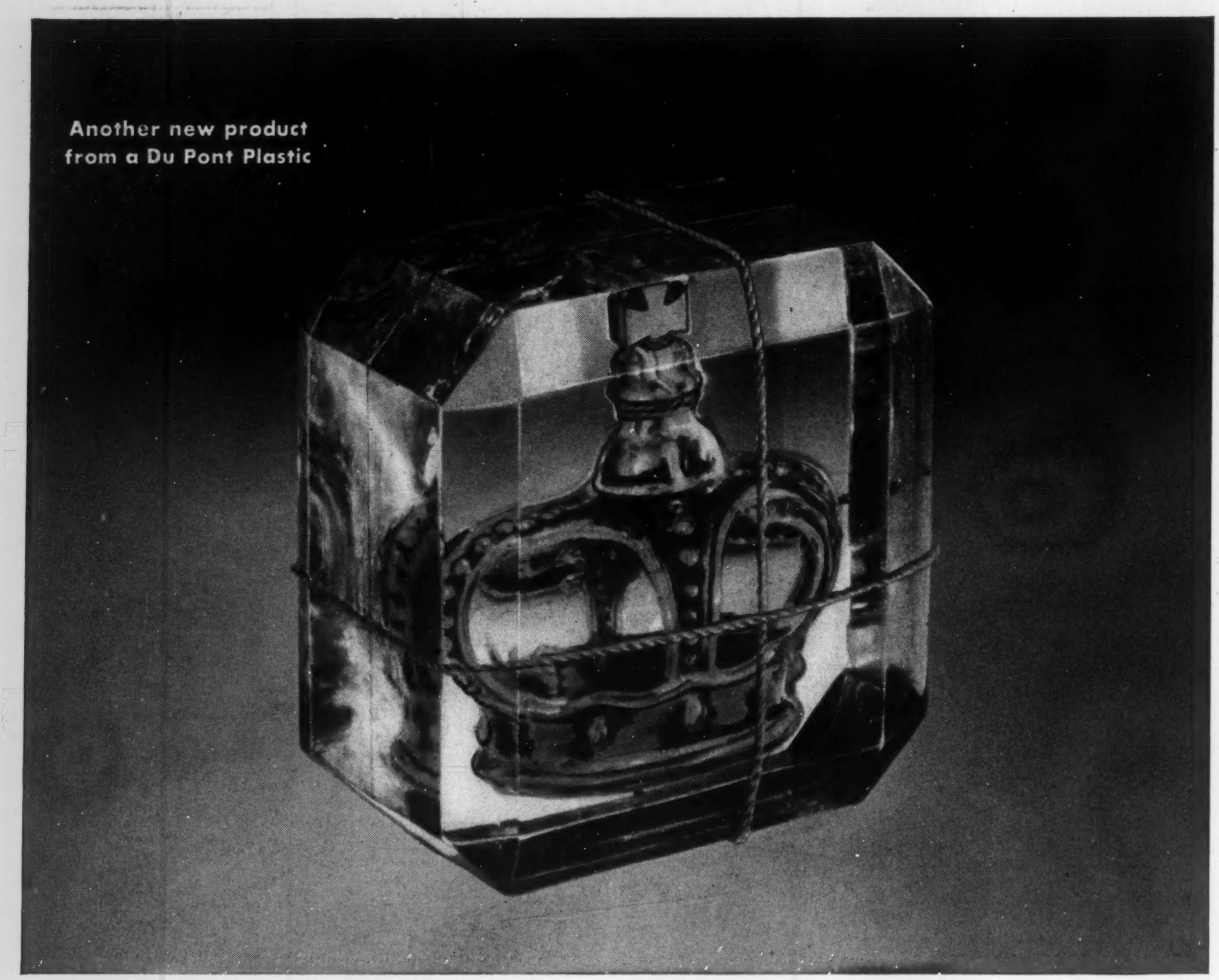
USE SUPERIOR STAINLESS STRIP STEEL

for better fabrication . . . and better consumer service!

The gleam of stainless in modern kitchens signifies more than *surface* quality—it highlights the solid resistance to corrosion, chipping, peeling or wear that *only stainless* can provide.

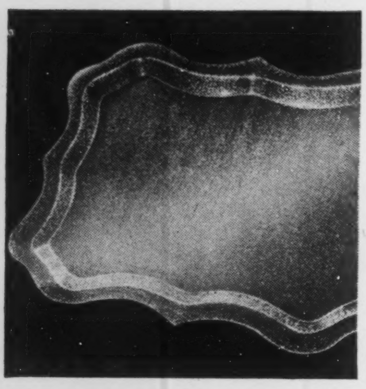
For maximum fabricating ease, use SUPERIOR Stainless Strip Steel. Precision-controlled in all analyses, dimensions, tempers and finishes, SUPERIOR Stainless is furnished in coils to speed your production processes—*uniformly fine* in every length. Write for our Stainless Brochure!

Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA



SOMETHING NEW IN SCENT'S APPEAL

Perfume package of Du Pont "Lucite" paves the way to new sales



WHAT'S NEW

It's *patterned* "Lucite" . . . in frosted, pebbled, and other smart designs. Seven different surface finishes are available. Soon many additional patterns will be on the market . . . bringing new beauty and new possibilities to products made of "Lucite" acrylic resin.

"LOVELY!" WOMEN SIGH . . . and men buy! They're stopped by the diamond-like brilliance and dramatic beauty of this new perfume package . . . made of Du Pont "Lucite".

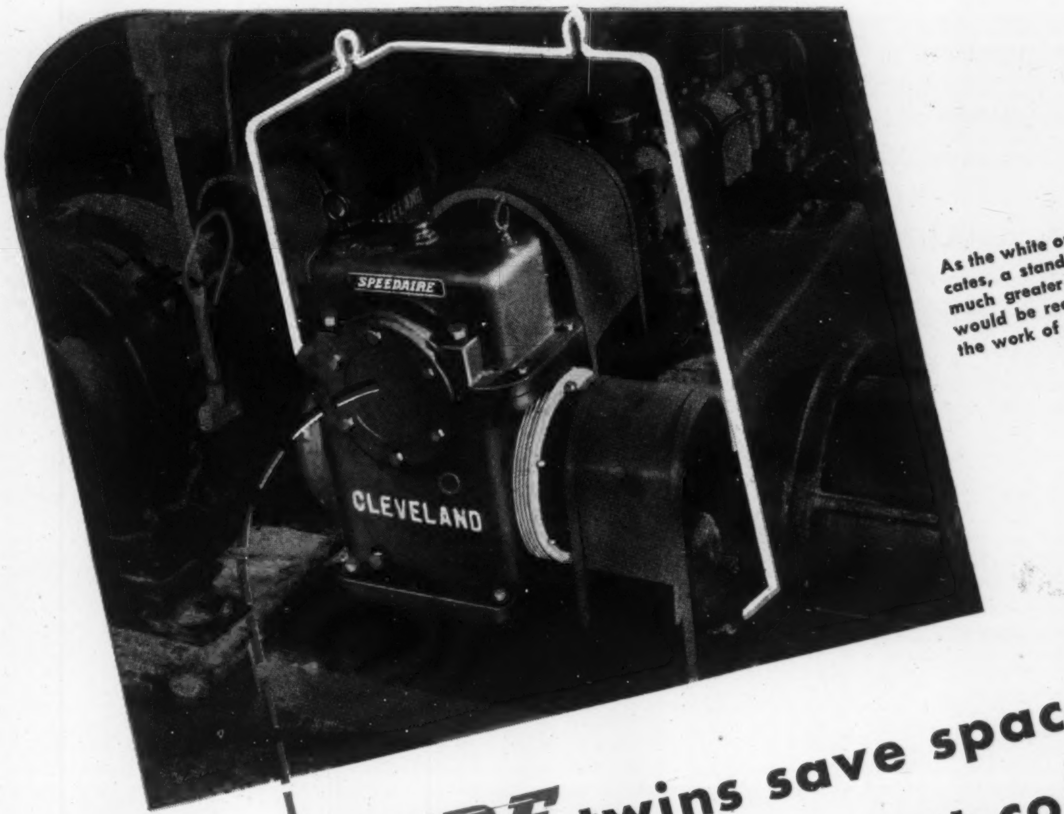
In planning the introduction of a luxurious perfume, Matchabelli designed this unusual faceted package to take full advantage of the crystal clarity, light weight, durability, and protective qualities of "Lucite".

For packages, "Lucite" acrylic resin gives shatter-resistance and crystal clarity in many colors; its ability to edge-light permits unusual illumination effects. "Lucite" recommends itself for a host of other uses, too, because it has good tensile and flexural strength, is chemically inert and can be easily and economically fabricated.

Investigate the properties of "Lucite" . . . and other Du Pont plastics. You may find a way to develop a new product, or a means of improving an old one. Write now for liturature. It will pay you to have it in your files. E. I. du Pont de Nemours & Co. (Inc.), Room 398, Arlington, New Jersey.

Prince Matchabelli perfume package, made by Industrial Conversions, Inc., New York, N. Y., was awarded the Beauty Fashion Award for 1946.

DU PONT
REG. U. S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY



As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

SPEEDAIRE twins save space, reduce weight, cut cost $385

THESE two Speedaires are installed in the northern New York mill of a well-known paper company. The reducer in the foreground drives a paddle wheel circulating hot-pond water; the other drives a chain conveyor bringing rough wood into the hot pond.

In operation over a year, the Speedaires are completely satisfactory. As is apparent from this photograph, they saved valuable space, permitting motors and drives to be grouped more closely. Load on the floor was reduced 1300 pounds (Speedaire's weight is less than half that of a conventional worm-gear reducer) and cost saving was $192.50 per unit.

Speedaire is Cleveland's new fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantages of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Company, 3265 East 80th Street, Cleveland 4, O. *Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.*

CLEVELAND
Worm Gear
Speed Reducers

JENKINS DESIGNERS' KIT
VALVE INFORMATION
Valve Headache Relief
INSTRUCTIONS for the INSTALLATION and MAINTENANCE of VALVES
WATCH THIS
Where to use VALVES
A GUIDE
106-A SERIES
Included..

IN EVERY JENKINS DESIGNERS' KIT

IT may not be *visible* among the booklets and data sheets on valves included in this new Jenkins reference file for product development men. But you'll agree Jenkins Designers' Kit is real valve "headache relief" when you apply its useful information in your choice of valves, for any product involving fluid control.

Valve "headaches" result from incorrect selection and improper placement in the hookup. By using the information in the Jenkins Designers' Kit, plus consultation with Jenkins Engineers when desired, you can be sure you are specifying the right valve in the right place.

But worse valve "headaches" result from haphazard specification of valves as an unimportant detail, and taking a chance that they will uphold your product's guarantee of trouble free performance. For, valve failure boosts expensive service calls, and the grief caused your customer soon sours him on your product.

Choosing Jenkins Valves for your product gives you something more than faultless performance that keeps servicing costs down. You get the extra sales advantage of the famous Jenkins Diamond Trade Mark . . . the prestige built by Jenkins 83 year reputation for quality and continuous, industry-wide advertising to over 750,000 readers.

Use the Jenkins Designers' Kit, and, if you wish, consult a Jenkins Engineer when planning new products, or redesigning present equipment that requires valves. Give your product, and its purchasers, the *extra value* of Jenkins Valves . . . *it costs no more.*

Jenkins Bros., 80 White Street, New York 13; Bridgeport, Conn.; Atlanta; Boston; Philadelphia; Chicago; San Francisco. Jenkins Bros., Ltd., Montreal.

Save time and trouble with this handy file of valve information.

JENKINS BROS. • 80 White St. • New York 13

Please send me the Jenkins Designers' Kit.

Name____________________

Company____________________

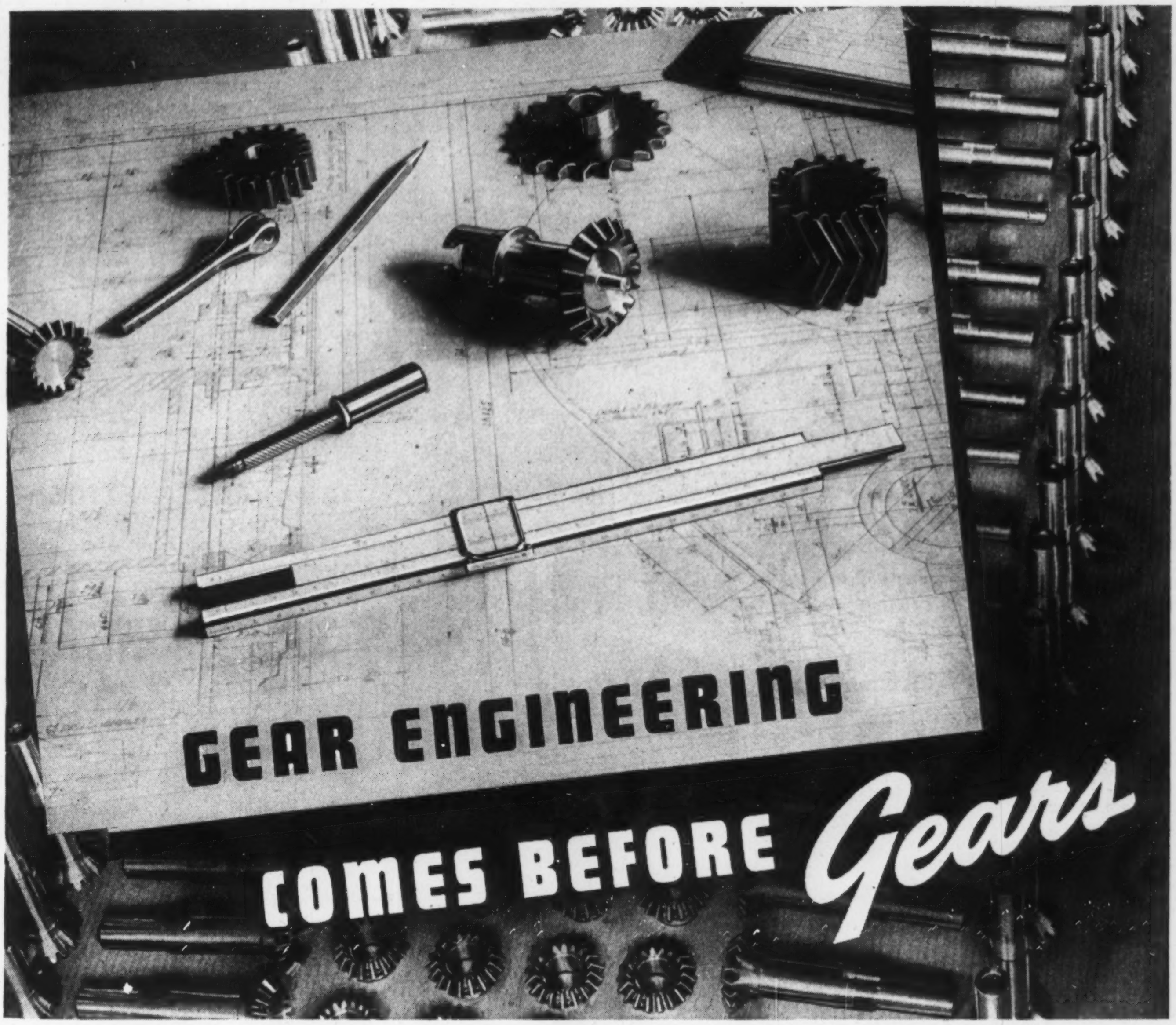
Address____________________

LOOK FOR THIS DIAMOND MARK

SINCE 1864

JENKINS VALVES

Types, Sizes, Pressures, Metals for Every Need



A Message to All Designing Engineers

With the establishment of West Coast branches and manufacturing plants, many midwestern and eastern companies are taking advantage of the complete services on geared products available through the facilities of Western Gear Works and its associate, Pacific Gear & Tool Works.

Three conveniently located plants offer you over a half century of gearmaking experience plus the services of specialists in your industrial field.

We have a complete line of mechanical power transmission equipment including speed reducers and increasers, Reeves Variable Speed equipment, Pacific-GE motorized speed reducers, couplings and Cone gear drives and reducers. We invite you to take advantage of the local service we can render your western installations.

Write, wire or phone our nearest plant or office for complete information.

WESTERN GEAR WORKS, Box 192, Lynwood, California
WESTERN GEAR WORKS, Seattle 4, Washington

PACIFIC GEAR & TOOL WORKS, San Francisco 3, California
SALES REPRESENTATIVES: Portland - Salt Lake City

AGMA
MEMBER

PACIFIC GEAR & TOOL WORKS — WESTERN GEAR WORKS

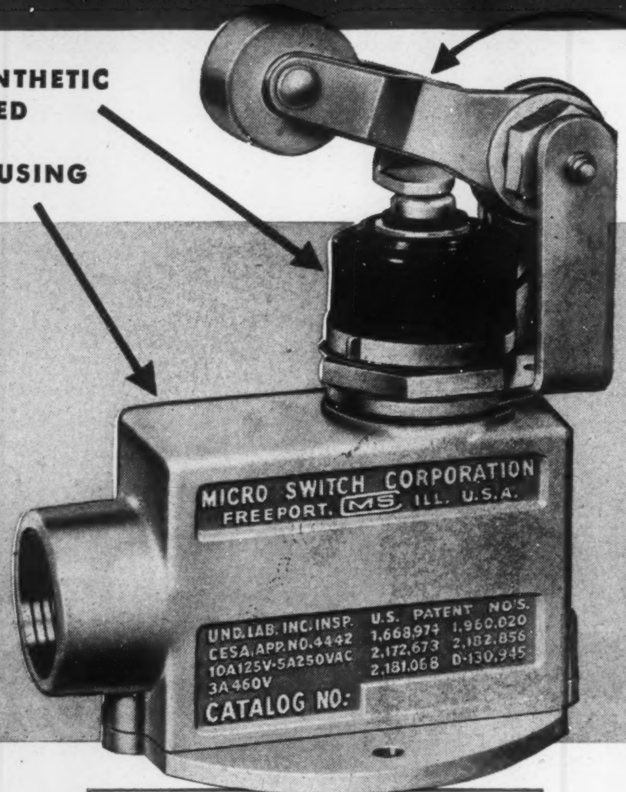
PACIFIC-WESTERN

GEAR PRODUCTS

• Fast delivery on many popular types and sizes of Speed Reducers from stock. •

MICRO *Precision*

with Roller Arm and Synthetic Rubber Sealed Plunger – Protects Against


PLUNGER—SYNTHETIC RUBBER SEALED
DIE CAST HOUSING
ROLLER ARM ACTUATOR
MICRO SWITCH CORPORATION
FREEPORT, MS ILL. U.S.A.
UND.LAB.INC.INSP.
CESA.APP.NO.4442
10A125V-5A250VAC
3A460V
CATALOG NO.:
U.S. PATENT NO'S.
1,668,974 1,960,020
2,172,673 2,182,856
2,181,068 D-130,945

CHARACTERISTICS

For use with fast cam and slide actuation and where vertical and horizontal adjustability of the arm is desirable.

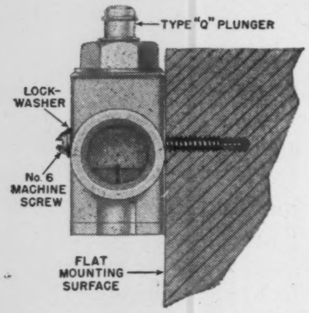
Vertically, the arm may be adjusted through any arc of 225°, and horizontally, the arm assembly can be adjusted to any of eight positions, 45° apart.

A return spring on the plunger prevents false actuation on snap-cam operation.

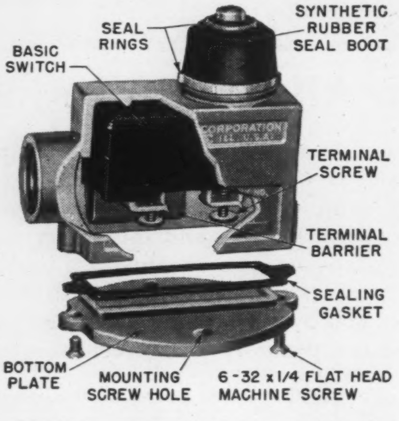
CHARACTERISTICS

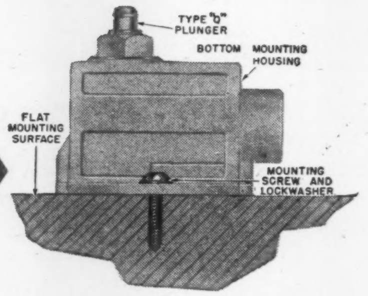
Characteristics as described below are at the roller end and at 90° angle from the arm.

Operating Force	10 to 18 oz.
Release Force	6 oz. in.
Pretravel	1/64" max.
Overtravel	¼" min.
Movement Differential	0.006" min.
Net Weight	0.74 max.

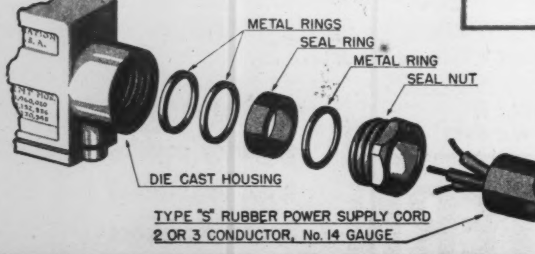

TYPE "Q" PLUNGER
LOCK-WASHER
No. 6 MACHINE SCREW
FLAT MOUNTING SURFACE

For Side Mounting. Two 6-32 x 1½" round head machine screws with lock washers and hex nuts are furnished. Screws extend through the sides of the housing and secure housing to either a thick or thin section.


SEAL RINGS
BASIC SWITCH
SYNTHETIC RUBBER SEAL BOOT
TERMINAL SCREW
TERMINAL BARRIER
SEALING GASKET
BOTTOM PLATE
MOUNTING SCREW HOLE
6-32 x 1/4 FLAT HEAD MACHINE SCREW


TYPE "Q" PLUNGER
BOTTOM MOUNTING HOUSING
FLAT MOUNTING SURFACE
MOUNTING SCREW AND LOCKWASHER

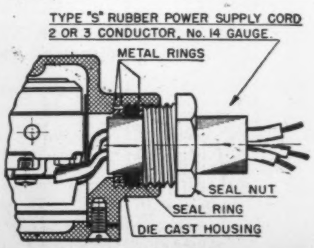
For Bottom Mounting. Provided with a ⅛" thick flanged bottom plate. In this flange are two 11/64" holes, one on either side of the switch housing. These accept No. 8 screws to secure switch to mounting surface.


METAL RINGS
SEAL RING
METAL RING
SEAL NUT
DIE CAST HOUSING
TYPE "S" RUBBER POWER SUPPLY CORD 2 OR 3 CONDUCTOR, No. 14 GAUGE

CONNECTING AND SEALING DEVICE

This device (which is supplied extra) should be used in combination with the sealed housing. It completely seals the switch connection against oil, water, dust and similar harmful agents. This combination, however, is not immersion proof.

The packet, known as No. 9-11444 consists of three metal rings, 1 seal ring and 1 seal nut, as illustrated.


TYPE "S" RUBBER POWER SUPPLY CORD 2 OR 3 CONDUCTOR, No. 14 GAUGE
METAL RINGS
SEAL NUT
SEAL RING
DIE CAST HOUSING

MADE WITH THE *"KNOW-HOW"* BEHIND MILLIONS OF PRECISION SWITCHES

Die Cast Switch

Sealed Plunger... *Now Available...*

Moisture, Dust and Abrasives

● The MICRO Precision Die Cast Switch with roller arm and synthetic rubber sealed plunger is introduced as a latest addition to the MICRO Switch line.

In keeping with MICRO Switch leadership of providing design engineers with the latest engineering achievements, this new switch was built to meet industrial requirements. It supplements and makes the MICRO Switch line still more complete.

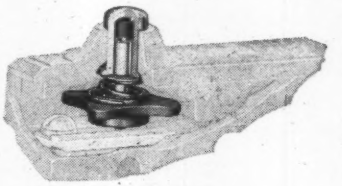
This roller arm actuated MICRO Switch is enclosed in a sturdy die-cast housing, with the plunger completely sealed by a synthetic rubber boot. A bottom-plate gasket adds a further protective seal to the switch.

This construction permits their use with complete success where equipment requires frequent washing or machinery is exposed to oil, grease, soap, fat, fruit juices or other moist conditions. The enclosure is a complete protection against dust and abrasives.

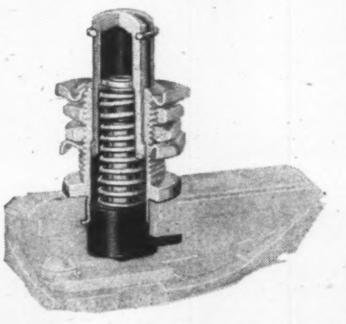
In addition to this new type switch, there are 3365 combinations of electrical characteristics, actuators and housings available to you in the MICRO Switch line. To determine the correct switch, MICRO engineers can help you. They have the "Know-How" and the wide experience in solving thousands of switching problems. Feel free to write in and ask for their aid. For convenience, many of your questions can be answered by writing the nearest MICRO Switch branch or sales representative as listed below.

The *"KNOW-HOW"* behind the manufacture of millions of switches dictates that actuators perform best when built like this...

THE "D" PLUNGER



THE "Q 1" PLUNGER



For purposes of precision, top performance, and long life—experience over a period of years and the "Know-How" gained in building millions of precision switches has proved that actuators, for top accuracy, should be an integral part of the switch.

If you are depending upon top performance, insist upon the actuator being part of the switch—don't chance a substitute method.

Here are a few examples—

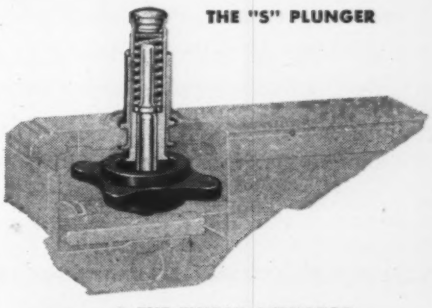
The "D" Plunger is a simple but rugged actuator well suited for use with slow moving cams, or as a mechanically actuated safety or limit switch.

The "Q1" Plunger with hardened tip moves in a threaded brass stem. 7/32" overtravel is provided by a spring mounted within the assembly.

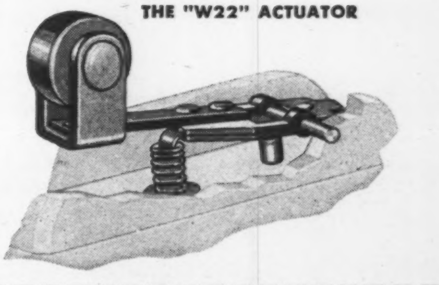
The "S" Plunger providing 1/16" overtravel has a hardened tip set in a steel sleeve to insure long life and accuracy.

The "W22" Roller Actuator provides a short lever suitable for slide or cam operation.

THE "S" PLUNGER



THE "W22" ACTUATOR



MICRO *Precision Switches*

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A DIVISION OF FIRST INDUSTRIAL CORPORATION
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TO YOUR SPECIFIC REQUIREMENTS

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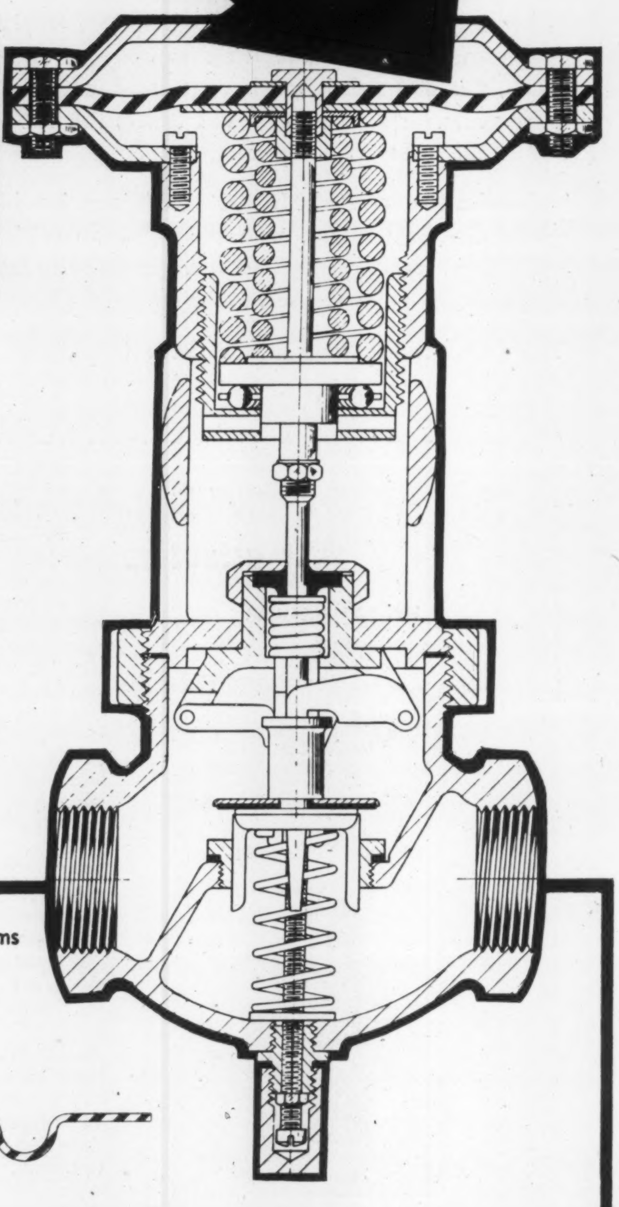
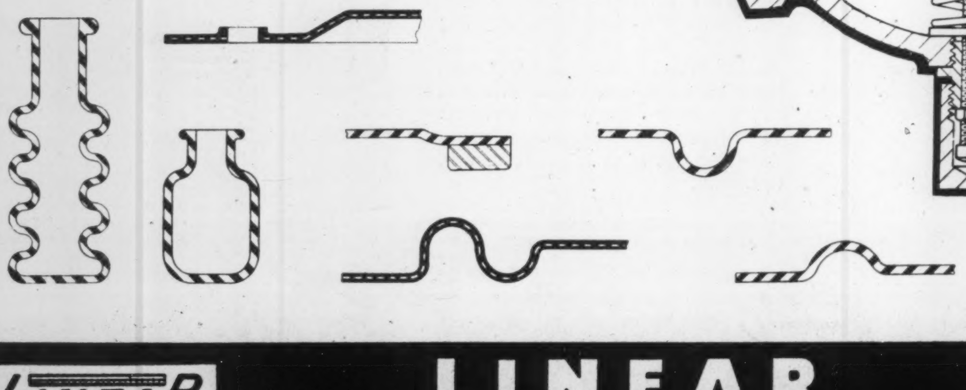
Linear's engineering knowledge and long experience are available to help you develop a diaphragm specifically designed for your application. Write today . . . give us complete engineering data and prints . . . we'll recommend the diaphragm of the material best suited to your needs.



A Few Typical Cross Sections of Linear Moulded Diaphragms



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OVER FORTY YEARS PACKING EXPERIENCE

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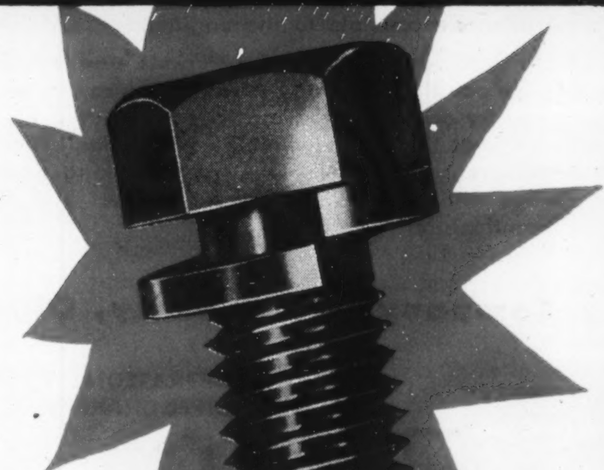
HERE'S MONEY-SAVIN' MAGIC

(Without the Aid of Mirrors)

SPRINGTITES "ADD HANDS" for PRODUCTION



Speed up your production by freeing hands on production lines—automatically balance your inventories—reduce your costs—eliminate waste with Eaton Springtites, the modern dual fastening device.

Eaton Springtites offer the maximum in advanced fastening engineering — a properly designed spring lock washer preassembled on a quality bolt or screw, correctly dimensioned to fit under bolt screw or bolt head. Tension is exerted at the proper point of leverage through improved fit on shank.

★ *Write* today on your letterhead for your copy of Springtite folder #200.

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EATON MANUFACTURING COMPANY

MASSILLON, OHIO *Reliance Division*

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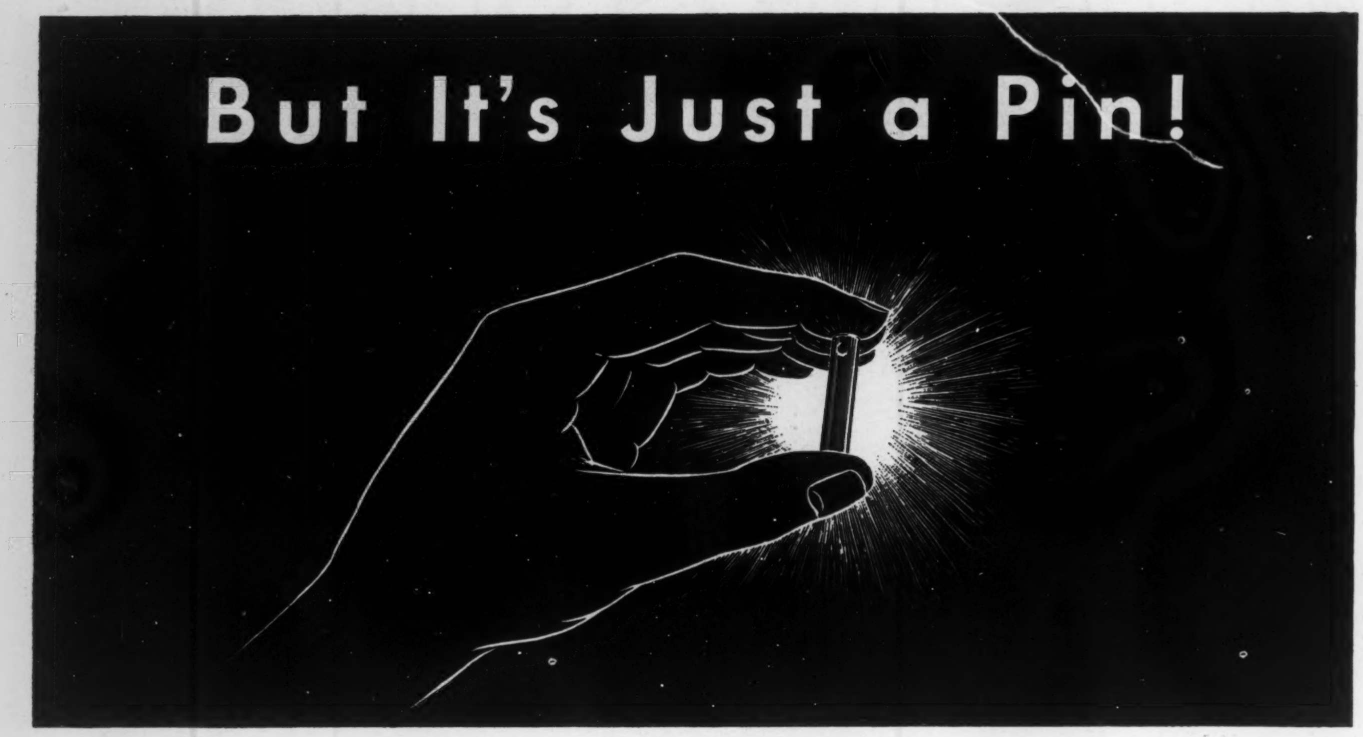

But It's Just a Pin!

This short length of UNION roller chain is made up of the 28 separate parts shown below.

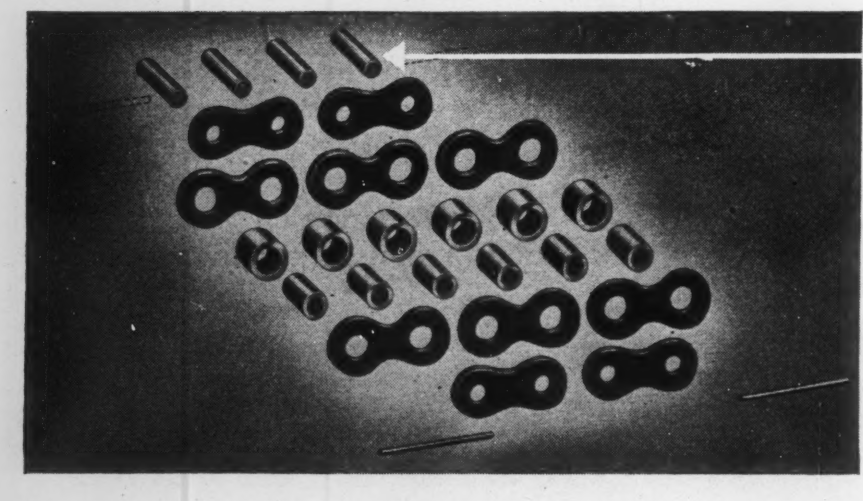
UNION CHAINS

Yes, it's a pin—just a small pin. But it requires 11 distinct and precise operations to make it. For this is a pin for a link of UNION roller chain, and together with the bushings and the rollers it accepts and withstands all the wear that a roller chain is subjected to.

If you will study the "exploded" drawing below you will see that there are 4 of these pins in the short length of UNION roller chain shown at the left. You will also see that there are a total of 28 separate parts in this same length of chain. To make them all, exactly 290 operations are required. And every step from receipt of material to finished product is under the careful supervisory control of an inspection department responsible to the engineering division.

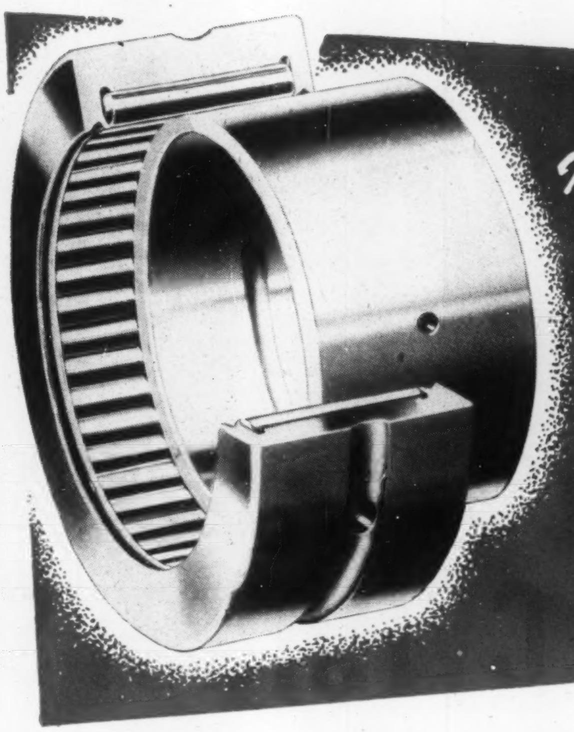
As specialists in the manufacture of sprocket chains, sprockets and attachments (we make nothing else!), we point with some pride to the high standards of skill and precision maintained by our engineers and craftsmen at UNION CHAIN. We are not yet able to meet the overwhelming demand for UNION chain, but we assure our customers and friends that we are making every effort to do so, consistent always with the character of our product and the complicated processes of its manufacture.

The Union Chain and Manufacturing Company • Sandusky, Ohio



THESE 11 OPERATIONS TO MAKE THIS STEEL CHAIN PIN:

1. straighten stock material
2. cut off to length
3. chamfer ends
4. carburize
5. drill for cotter pin hole
6. re-heat and quench
7. re-heat to refine core structure
8. draw to relieve internal strains
9. rough grind
10. finish grind
11. anneal end for riveting

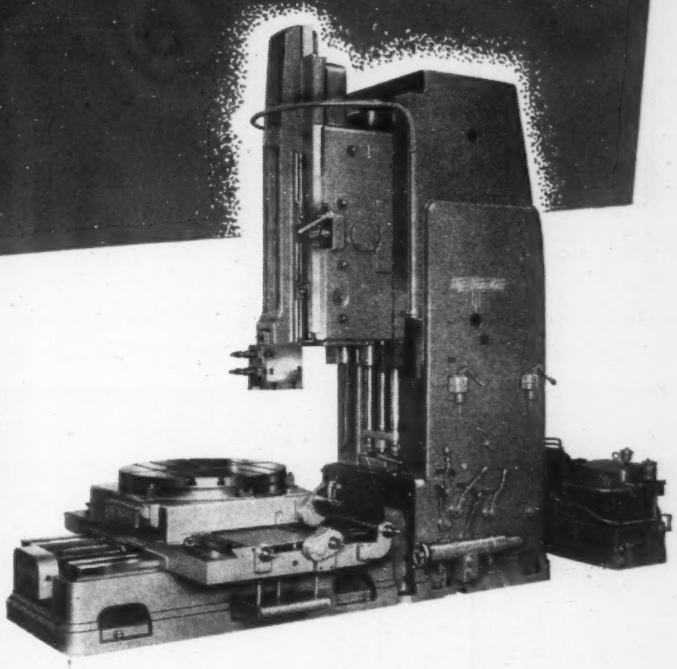


Increase Machine Dependability

WITH

McGILL "SOLIDEND" MULTIROL

PRECISION BEARINGS



22 McGILL MULTIROL BEARINGS

IN THIS ROCKFORD HYDRAULIC SLOTTER

McGILL, the ideal bearing for precision heavy duty applications, proves its dependability in this ROCKFORD HYDRAULIC SLOTTER built by Rockford Machine Tool Co., Rockford, Illinois. At 22 critical points in the feed box, index head, rotary table drive, and rotary feed gear box McGILL high load capacity and balanced design insure accuracy and efficiency of this machine. Rivaling the hydraulic ram movement for smooth action, McGILL BEARINGS in the feed mechanisms result in unusually fine finish cuts. The longer life of the McGILL BEARINGS, due to the rigid construction, and adequate lubrication facilities, improve the performance of the ROCKFORD SLOTTER . . . helps keep maintenance at a minimum.

McGill Selected for

• LONG LIFE • SMOOTH ACTION • DEPENDABILITY

Machine tools or any precision machinery needs McGILL high load capacity . . . precision accuracy . . . dependability. McGILL BEARINGS are manufactured in a full range of standard sizes to suit any application. They include the *MULTIROL**, *MULTIROL* CAM FOLLOWER*, SOLIDEND *MULTIROL**, full type roller bearings, and non-ferrous metal retainer ball bearings.

Write today for free catalog to: McGill Manufacturing Company, Inc., 200 North Lafayette Street, Valparaiso, Indiana.

*T.M. Reg.

1947 MACHINE TOOL SHOW
CHICAGO SEPT 17-26

Booth 549

McGILL
precision bearings

talk about

PUSH!

you're talking about

gerotor air cylinders

Gerotor double-acting, non-rotating Air Cylinders have all the "push" you need for efficient 150 p.s.i. air service. Available in seven standard mountings, nine bore diameters, strokes up to 96".

Features include:

(1) Self-adjusting composition rod packing.
(2) Ample bronze rod guide.
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(4) Self-adjusting composition cup packing.
(5) Heavy-duty piston assembly.
(6) Piston rod and assembly firmly secured.
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(8) Large pipe connections rotatable to any position.
(9) Keeper ring design that eliminates tie rods.

Write for Catalog Section 52 . . . today!

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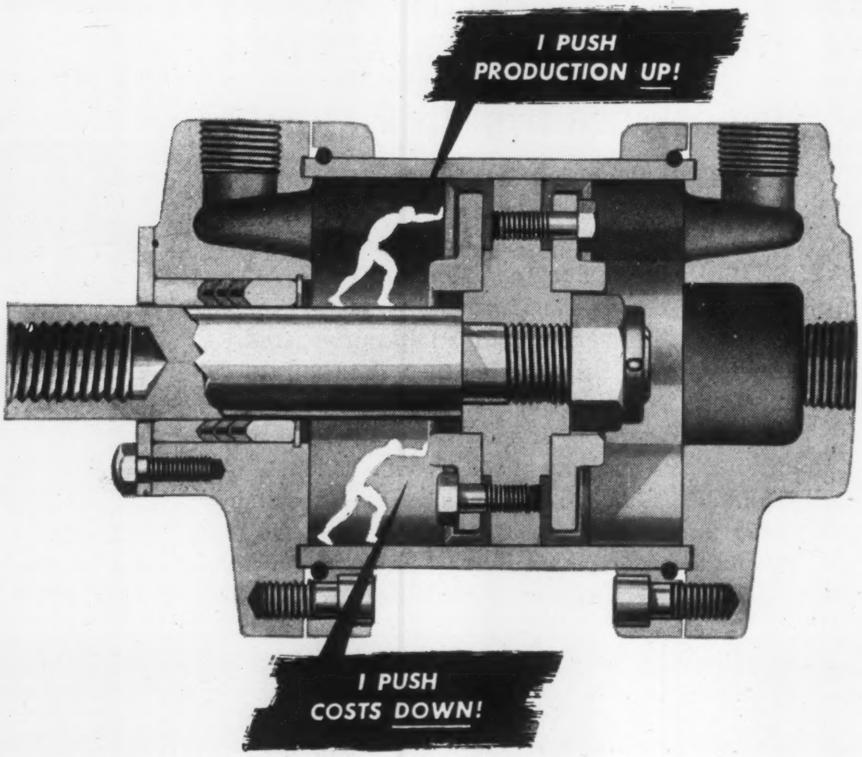
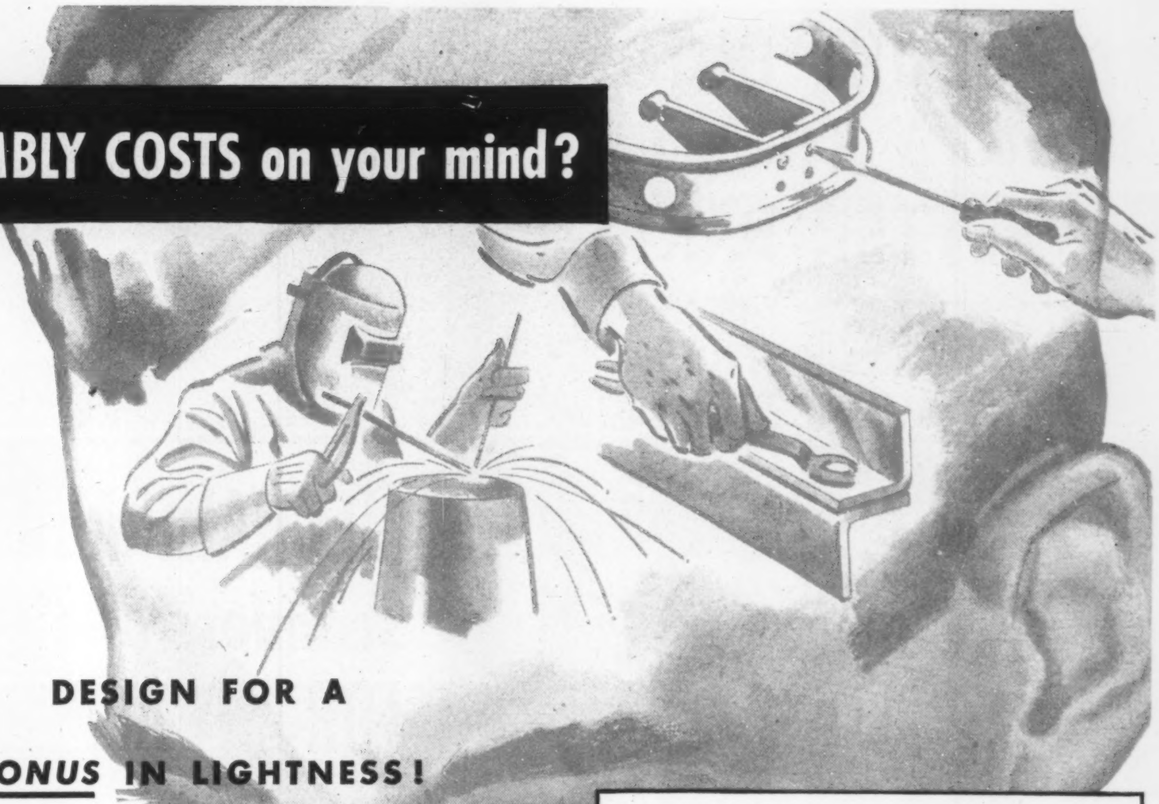


GEROTOR air valves & cylinders

hydraulic pumps, pump units, motors, valves, cylinders

ASSEMBLY COSTS on your mind?



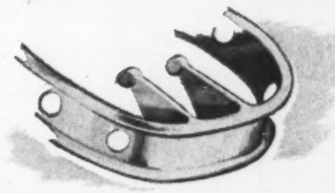
DESIGN FOR A

BONUS IN LIGHTNESS!

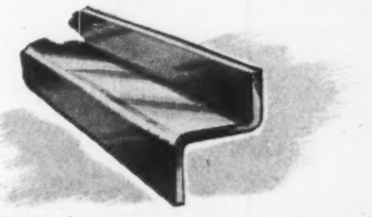
Many American Magnesium products not only simplify assembly, but give *your* product a bonus in lightness besides! For American Magnesium is 35% lighter than aluminum, 75% lighter than steel!

You should know these semi-fabricated forms of American Magnesium, and the ease with which they can be applied to your design problems. And you should take full advantage of the 59 years of light-metal know-how of Aluminum Company of America, that stands ready to help.

At the right, are indicated the forms of American Magnesium that can simplify assembly problems in your plant. To answer the questions of their application, call your nearest Alcoa sales office, or write ALUMINUM COMPANY OF AMERICA, sales agent for American Magnesium products, 1703 Gulf Building, Pittsburgh 19, Pennsylvania.



ASSEMBLY OF stamped or cast parts may be simplified by an American Magnesium Permanent-Mold Casting. A single, high-speed cut brings it to desired finish and dimensions.



BUILDING UP of complex assemblies can be avoided with the use of American Magnesium Extrusions. Made to desired profiles. Die cost is low.

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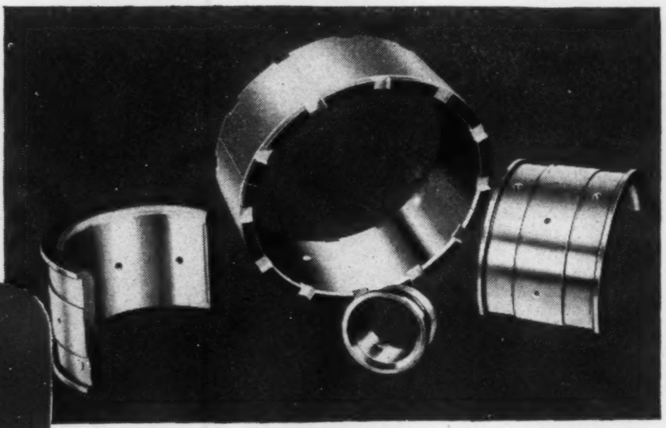
SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

SHORT CUTS
TO
BETTER PARTS



STAINLESS CROLOYS
B&W ALLOYS
SAE ALLOYS
NE ALLOYS
NITRALLOY STEELS
SPECIAL ANALYSES
CARBON STEELS
HOT FINISHED
COLD DRAWN
SEAMLESS
WELDED

MECHANICAL TUBING
seamless and welded
FOR ANY APPLICATION

Hollow structural assemblies and precision working parts made from B&W Mechanical Tubing give *lightweight* construction with *heavyweight* ruggedness and dependability—show important savings in production time, costs and materials over the use of forgings and bar stocks.

From its modern specialty tube mills, B&W can supply mechanical tubing—either seamless or welded—of the proper analysis, size, gauge, temper and finish for making practically any hollow machined or fabricated part . . . better, faster, cheaper. In fact B&W Mechanical Tubing embraces the widest range of analyses available from one source. So no matter what kind of steel tubing you need—from plain carbon to high alloy grades—B&W makes it.

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TA-1409 M

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THE BABCOCK & WILCOX TUBE COMPANY
GENERAL OFFICES: BEAVER FALLS, PA.
PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO.

B&W

Seamless and Welded Tubular Products in a full range of Carbon, Alloy, and Stainless Steels for All Pressure and Mechanical Applications.

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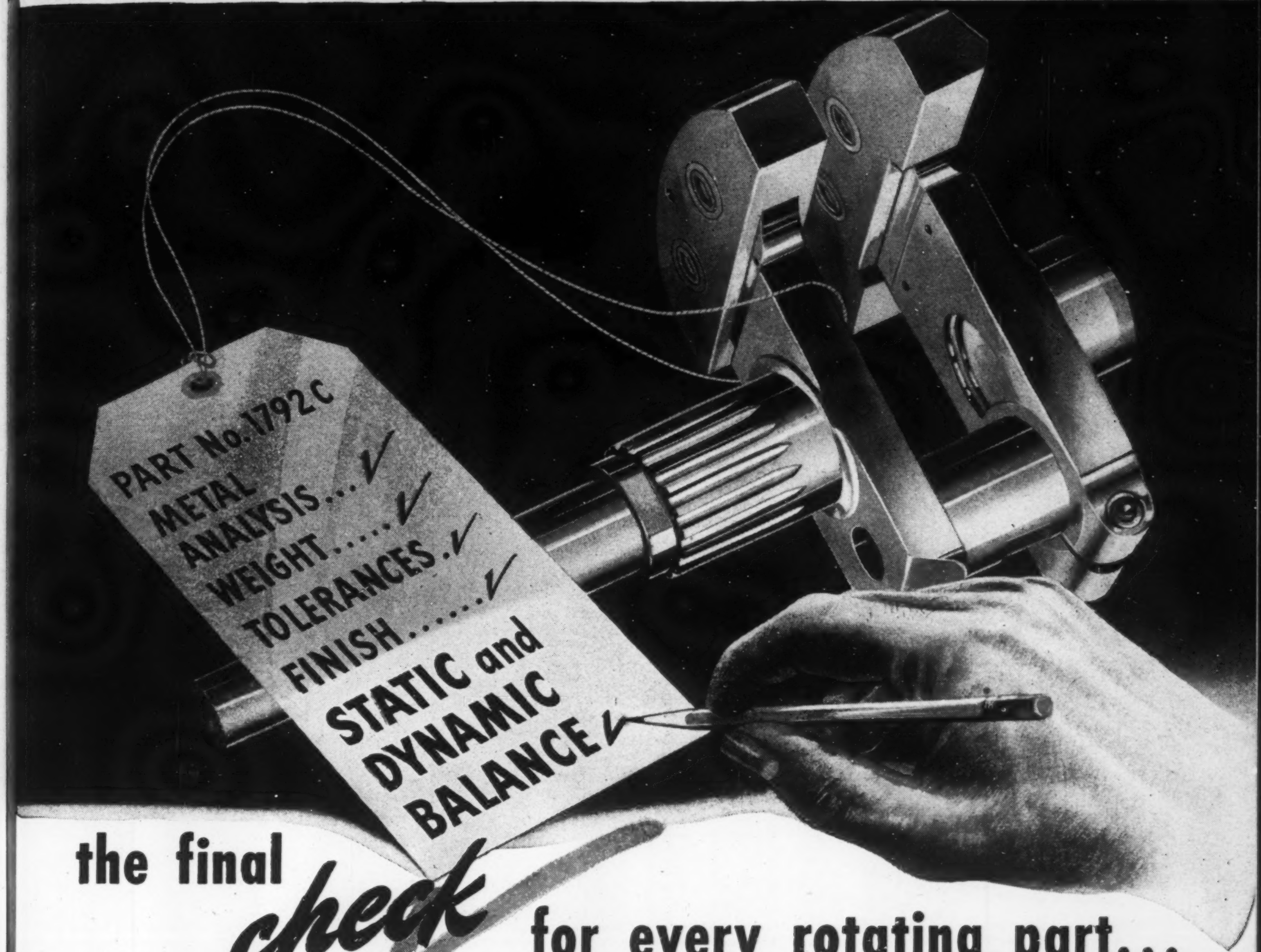


the final *check* for every rotating part...

MAYBE it's a crankshaft or an armature . . . perhaps a fan or belt pulley. No matter. The important thing is this—if it isn't *balanced,* it isn't ready for service.

Smooth operation and long life require that accurate static and dynamic balance be rated right up with mechanical specifications—incorporated in the blueprints. Then no vibration, however slight, may lower the efficiency of the finished product.

GISHOLT DYNETRIC* BALANCING MACHINES‡ use electronics to detect unbalance vibrations as small as .000025" . . . handle any rotating assembly from one-half ounce up to 50 tons! In a matter of seconds, the destructive forces are *located, measured* and *ready for correction.*

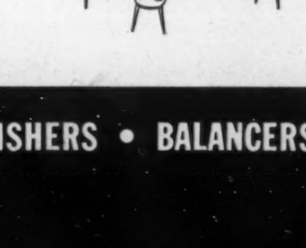
The cost? Very moderate. That's why so many manufacturers insist that their products have the final check which only Gisholt Balancing Machines can provide.

**DYNETRIC is a trade-mark Reg. U. S. Pat. Off. by Westinghouse Electric Corporation.*
‡Developed jointly with Westinghouse Electric Corporation.

GISHOLT MACHINE COMPANY
Madison 3, Wisconsin

See the five operating exhibits of Gisholt Balancing Machines at the Machine Tool Show.

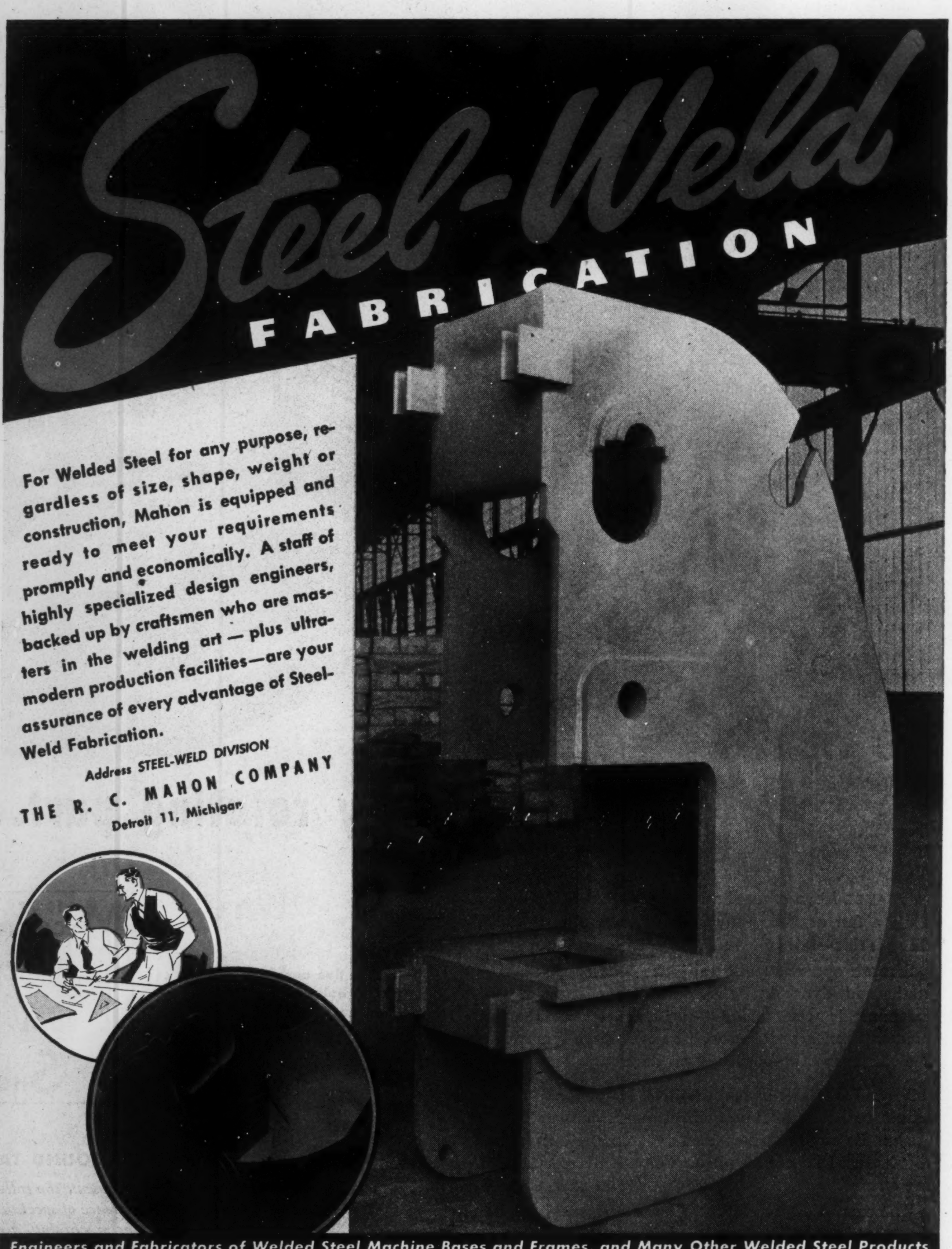
1947 MACHINE TOOL SHOW
CHICAGO SEPT 17-26



The GISHOLT ROUND TABLE

represents the collective experience of specialists in the machining, surface-finishing, and balancing of round and partly round parts. Your problems are welcomed here.

TURRET LATHES • AUTOMATIC LATHES • SUPERFINISHERS • BALANCERS • SPECIAL MACHINES



Steel-Weld FABRICATION

For Welded Steel for any purpose, regardless of size, shape, weight or construction, Mahon is equipped and ready to meet your requirements promptly and economically. A staff of highly specialized design engineers, backed up by craftsmen who are masters in the welding art — plus ultra-modern production facilities—are your assurance of every advantage of Steel-Weld Fabrication.

Address STEEL-WELD DIVISION
THE R. C. MAHON COMPANY
Detroit 11, Michigan

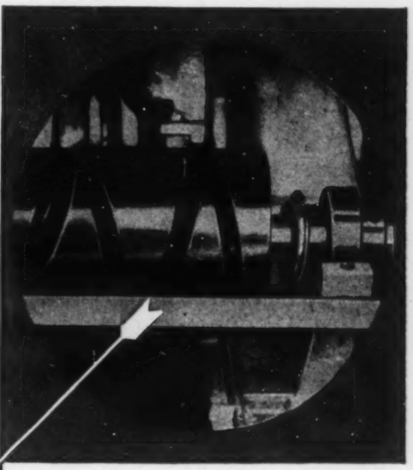
Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

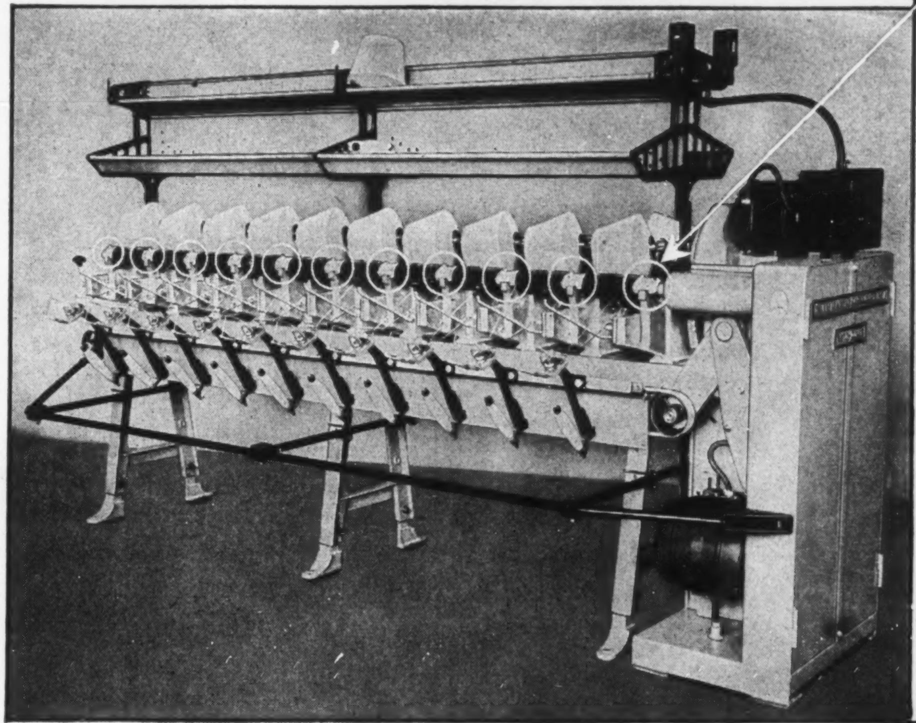
MAHON

FRICTION PROBLEM?

There is a NICE *answer*

NICE Ball Bearings overcome Friction in modern design of Textile Machinery

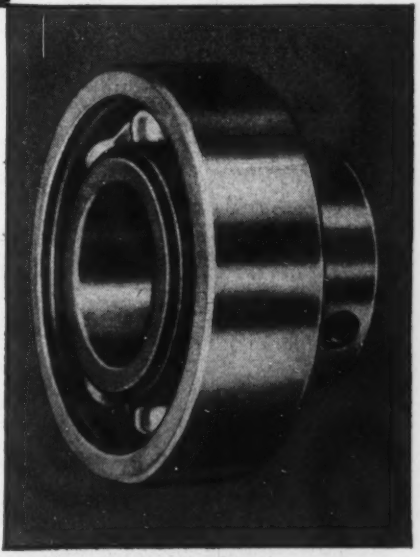




Above: Exposed view of bearing mounting.

Left: The Roto-Coner* Winding Machine, manufactured by the Universal Winding Company, Providence, Rhode Island.

Below: Nice No. 6411 Special, a modification of Standard No. 1635 SS of "Series 1600", a new *inch size* line of *low cost* Precision Radial Bearings with Solid Inner and Outer Rings and Ball Retainer.



Typically representative of the modern design employed by the Universal Winding Company of Providence, Rhode Island, is the illustrated Roto-Coner* Winding Machine which incorporates NICE BALL BEARINGS at the Friction points indicated.

Designed especially for this application, these NICE bearings not only help to make possible advantageous design and production features from the standpoint of the manufacturer, but also contribute to increased production, power savings and greater utility to the benefit of the user.

• • •

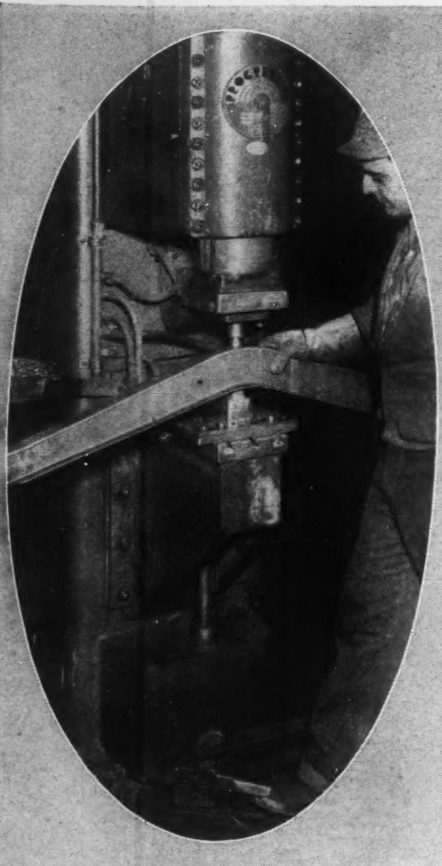
For price and engineering data on the complete line of NICE BALL BEARINGS and other ANTI-FRICTION PRODUCTS, write for Catalog No. 125.

*Reg. U. S. Pat. Off.

NICE

NICE BALL BEARING COMPANY

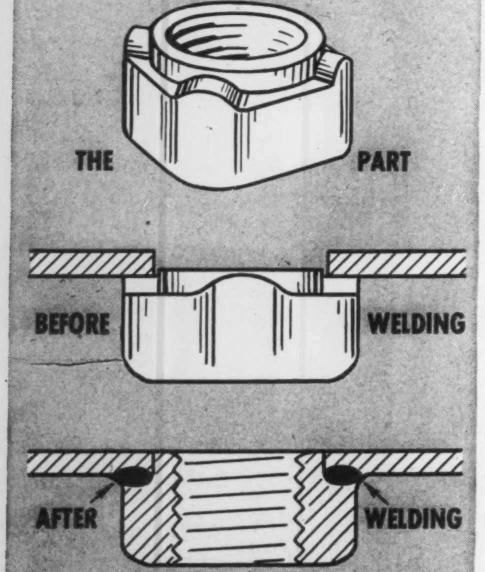
NICETOWN · PHILADELPHIA · PENNSYLVANIA



How to Attach a threaded nut

The simplest and best way to attach a nut is to THREAD IT FIRST and then projection weld it to the part. That's what Midland Steel Products is doing on automobile and truck frames—using a Progressive Press Welder. NO RETAPPING is necessary after welding.

Formerly either arc-welded or mechanically attached to frames, these nuts (see sketch) are placed in a die on the lower platen of the welder. The part is slid along until a registering hole drops over the shoulder on the nut. The upper platen is brought down, one shot of current is passed through the nut, fusing the projections to the side-rail and the job is finished. A dozen or more nuts are attached to the side-rail shown in this manner. Nuts range in size from ¼ to ½ inch.



If you have a problem of attaching threaded studs or nuts to other parts, consult Progressive's PROCESS ENGINEERING DEPARTMENT. We will be glad to help you.

Are you reading Progressive's Resistance Welding Pictorial? Here you will find each month case histories of how WELDINGENUITY is cutting manufacturing costs and improving product appearance, performance and life. Ask for it on your company letterhead.

IT PAYS TO WELD

CABLE ADDRESS "PROGWELD"

MEMBER
RESISTANCE WELDER MANUFACTURERS' ASSOCIATION
RWMA

PROGRESSIVE Welder Co. 3050 E. OUTER DRIVE • DETROIT 12
RESISTANCE WELDING EQUIPMENT

A NEW I. D. FOR YOU

Now, a ready-to-use Wolverine Trufin

You no longer need to perform costly stripping or expanding operations on Wolverine Trufin tube prior to making end connections. Instead, the Inside Diameter of Trufin is controlled; and inserted end connections can be easily and economically made by brazing any standard tube into THE integral finned tube. You can readily utilize any length or random lengths by simply cutting Wolverine Trufin to meet your requirements.

All connecting tubes, whether flared, threaded, bent, etc. can be assembled to Trufin without any additional preparation.

Send for our new Form S-651, which gives complete specifications and other helpful information about Wolverine Trufin—THE integral finned tube.

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CALUMET & HECLA CONSOLIDATED COPPER COMPANY

MANUFACTURERS OF SEAMLESS COPPER & BRASS TUBING

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for packing and bottling

for farm implements

ask the Rex man!

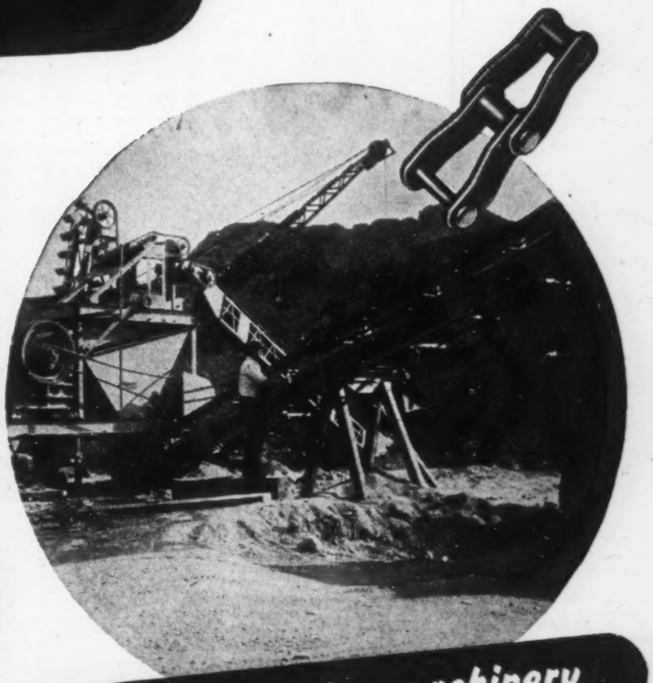
No matter what type of machine you design . . . construction machinery, farm implements, packaging and bottling machines, ovens, etc. . . . you can simplify your chain selection problems by consulting the Rex Man.

You'll find him an expert in power transmission and conveying . . . ready, willing and able to assist you to specify the chain that will be right for the job . . . that will assure the best in efficient, economical service.

The Rex Man is an experienced chain application engineer and he's backed by a complete line of chain belts, manufactured in every avail-

REX CHAIN BELTS

right chain?



for construction machinery

able size and type. With his assistance, you will avoid high cost due to overchaining and excessive wear and breakage caused by underchaining. He will demonstrate how a properly engineered chain drive can save space, help simplify design, and add to product salability by reducing maintenance costs and prolonging service life.

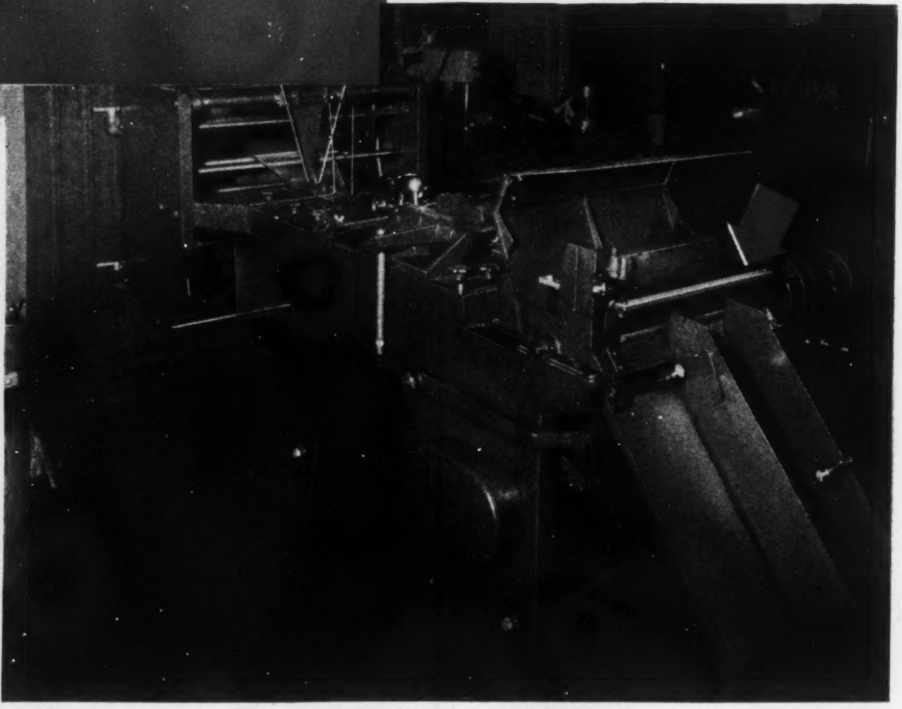
There is a standard Rex chain belt that exactly fits your design requirements and the Rex Man can help you select that *right* chain for your every need! Call him or write direct to Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wisconsin.

for ovens

CHAIN BELT COMPANY
of Milwaukee . . . . .

How to "design-out" *static troubles...*

- ***...on Coating and Finishing Machines***
- ***...Packaging and Envelope Machines***
- ***...Printing Presses***
- ***...Production and Processing Equipment for Cellulose Sheeting, Cellophane, Rubber, Synthetics, Paper Stocks***
- ***...Textile Machinery***
- ***...Photographic Print Driers***
- ***...Microbalances***
- ***...Other Equipment in which Friction Generates Static Electricity***



A GOOD BAG-MAKING MACHINE is made even better with an Ionotron Static Eliminator. Arrow shows location of Ionotron at delivery end of Shumann automatic bag maker, product of Shumann Equipment Company. Ionotron makes finished bags easier to handle and to fill, by eliminating static-caused cohesion of cellophane, Pliofilm, foil, or Glassine bags as well as adhesion to chute.

Users of many kinds of machinery find friction-generated static electricity a serious problem. It interrupts production ... makes materials difficult to handle ... causes product irregularities ... creates fire and explosion hazards.

If static is a potential source of trouble in the machine you're designing, you can easily make that machine more attractive to prospective buyers by including an Ionotron Static Eliminator* at the trouble zone – either as standard equipment or as an accessory. The Ionotron – employing a unique, highly efficient method of eliminating static problems – is itself so simple that it can be applied to almost any equipment *without alteration of basic design.*

The Ionotron is a metallic bar which supports and houses a source of continuous alpha radiation. The rays ionize the air in the critical zone. The ionized air conducts static charges to ground. The action of the Ionotron is permanent – it requires no contact with moving materials – has no moving parts – requires no power connection – and entails no operating cost!

Ionotron Static Eliminators are giving effective service on the types of machines listed above. To find out what the Ionotron can do for you – on the machine you're designing or on equipment you're using – send us complete details of the static trouble zone. We'll give you the information you need for further consideration of the application you have in mind. No obligation, of course. *Write Dept. J4, U. S. Radium Corp., 535 Pearl St., New York 7, N. Y.*

*Trade-mark reg. U. S. Pat. Off.

OTHER PRODUCTS OF U. S. RADIUM: Luminescent Materials: *radioactive, fluorescent, phosphorescent* • *LUMINESCENT DIALS: radioactive, fluorescent* • *POWDERS: cathode-ray tube, television tube* • *RADIUM LOCATORS: pendants, lenses, buttons, screws, markers* • *RADIOACTIVE FOILS (alpha-ray ionization sources)* • *HIGH-ACCURACY DIALS (nonluminescent)* • *SILHOUETTE ILLUMINATION of clocks, watches, and instruments LUMINOUS RETICLES and other specialties*

IONOTRON
Static
ELIMINATOR

Un-roll your own

. . . and cut shapes to suit the job or we can die-cut them to your order

Where tough, flexible and resilient forms of blown sponge rubber sheet are needed in your processes or product, you'll say Spongex* is "just made" for your requirements.

For manufacturers who prefer to use their own facilities for the production of die-cut gaskets and other special shapes, we furnish Spongex sheet stock made to their specifications. In thickness up to 1", it can be had in many densities, in continuous sheet rolls, or in smaller sections.

Spongex*
sheet stock
in rolls
or cut shapes

Our die-cut gaskets, and other forms made from sheet stock, are produced in any desired size or shape in a variety of densities. They may be had in various thicknesses depending on application or requirements with skin on one or both sides.

Send for descriptive circulars and samples as required for experimental purposes. We solicit correspondence from manufacturers with gasketing, sealing or other requirements. Sponge Rubber Products Co., 267 Derby Place, Shelton, Conn. Sales Offices in principal industrial centers.

**Trade Mark Reg. U. S. Pat. Off.*

SPONGEX* **CELL-TITE*** **TEXFOAM*** **TEXLOCK*** **TEXLITE**

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SPONGE RUBBER PRODUCTS CO.

WORLD'S LARGEST MANUFACTURER OF CELLULAR RUBBER AND BONDED FIBRE PRODUCTS

Delivers High Torque at Slow Speeds

Twin Disc Model PH-42 Air-actuated Clutch (three-plate construction). *See an Air-actuated Clutch and other Twin Disc units at Booth 453, Chicago Machine Tool Show, Sept. 17-26.*

A clutch that delivers high working torque for slow speed application is now available in the Twin Disc Clutch Company's new Model PH Air-actuated Clutch.

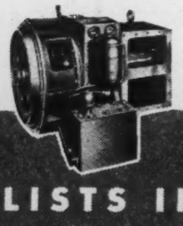
Ideal for heavy-type machinery and applications such as punch presses, brake presses, forging machines, etc., the Model PH is offered in 30″, 36″ and 42″ sizes, both two and three-plate construction, and torque capacities of up to 89,550 foot-pounds. Horsepower capacities for the complete line now range from 75 to 1325 hp.

This large Model PH Clutch incorporates all the proved advantages of the smaller air-actuated clutches, plus heavier, new-type spline tooth construction on the clutch hub, center plates, and floating plates. To counteract heavy shock loads and to reduce gear teeth wear, Models PH-36 and PH-42 Clutches are built with a two-piece back plate construction incorporating an alloy iron back plate assembled on a forged steel hub.

Write the Twin Disc Clutch Company, Racine, Wisconsin, for the new Bulletin No. 139-A which covers the complete line of Air-actuated Clutches. TWIN DISC CLUTCH COMPANY, Racine, Wis., (Hydraulic Division, Rockford, Ill.).

Heavy Duty Clutch

Hydraulic Torque Converter



Machine Tool Clutch

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
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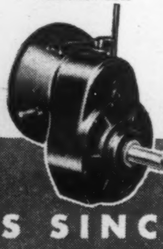
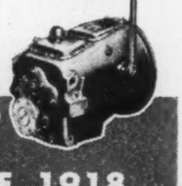
Reduction Gear



Marine Gear

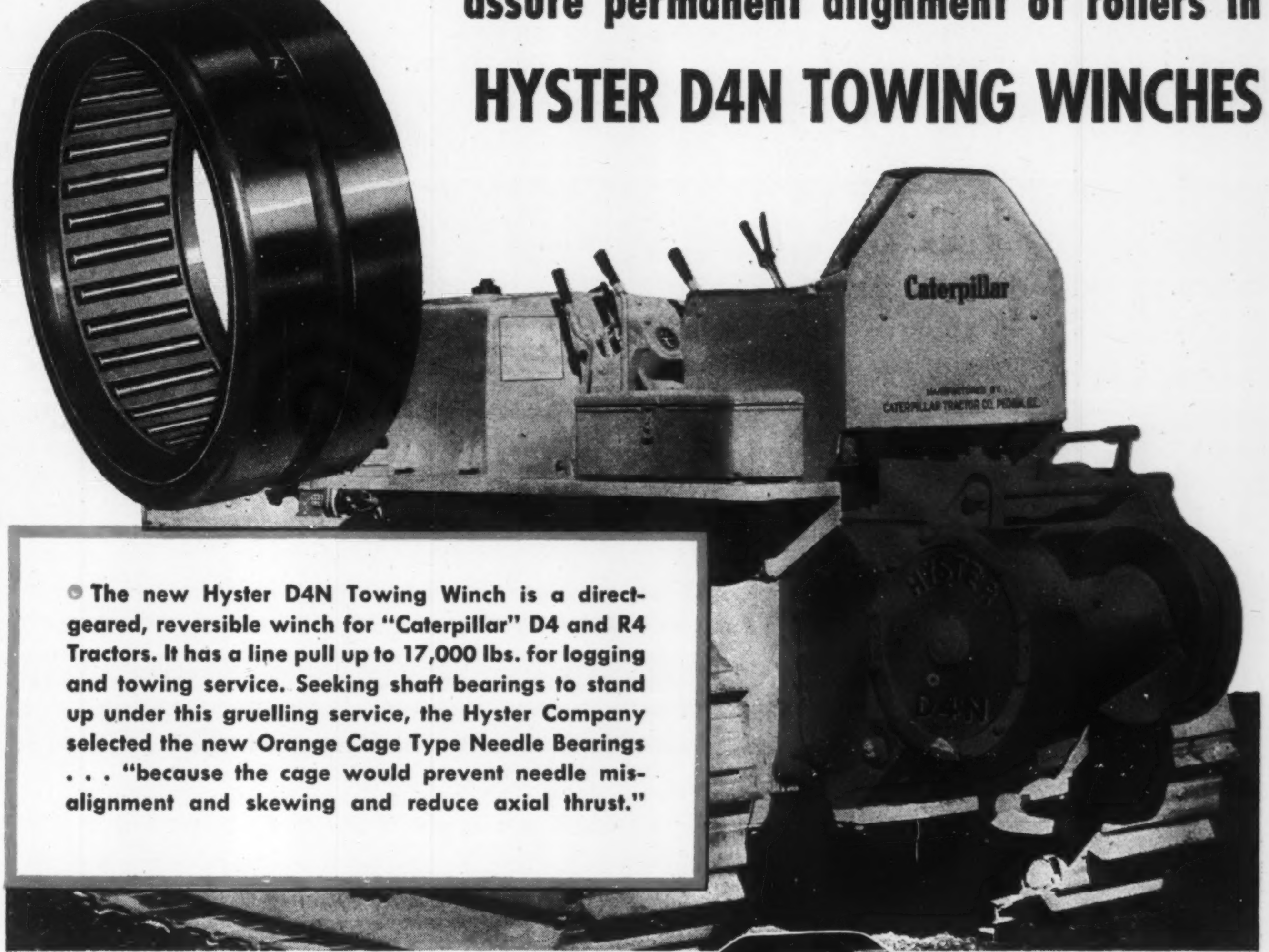


SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

ORANGE *Cage Type* NEEDLE BEARINGS

assure permanent alignment of rollers in

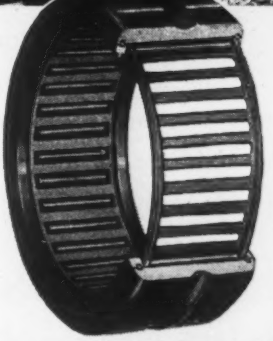
HYSTER D4N TOWING WINCHES



● The new Hyster D4N Towing Winch is a direct-geared, reversible winch for "Caterpillar" D4 and R4 Tractors. It has a line pull up to 17,000 lbs. for logging and towing service. Seeking shaft bearings to stand up under this gruelling service, the Hyster Company selected the new Orange Cage Type Needle Bearings . . . "because the cage would prevent needle misalignment and skewing and reduce axial thrust."

THE new Orange Cage Type Needle Bearings are especially adapted for spindles and high speed applications where requirements are exacting. They are unusually successful in vertical or overhung applications and are less affected by misaligned mountings. The cage design provides permanent alignment of rollers—less internal friction—smoother running—longer life hours expectancy.

Why not investigate today? Our engineers are glad to consult on any application. Send coupon for Engineering Data Folder showing construction, advantages, capacities and range of sizes available.



● Cross-section shows square-end rollers in coined pockets of free-rolling cage, made of anti-friction, non-ferrous metal. Internal clearances can be controlled to meet exacting specifications. All rollers and raceways are "Pentrate" finished to reduce friction, aid lubrication, increase durability and resist rust or corrosion.

ORANGE ROLLER BEARING CO., INC.
556 Main Street, Orange, N. J.

Mail Coupon for Engineering Data

ORANGE ROLLER BEARING CO., INC. MD
ORANGE, NEW JERSEY

Please send me Engineering Data on new Cage Type Needle Bearings.

Name.......................Title.............
Company..
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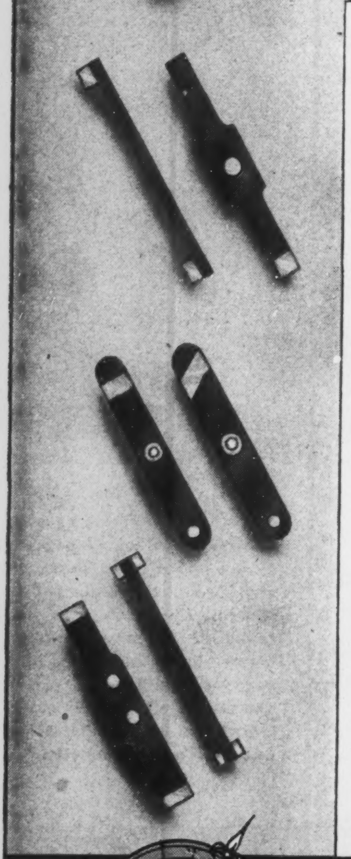
City...............................State.......

"RAISED-LAY"*

The *NEW* material for Electrical Bar Contacts



This *new* material consists of one or more strips of precious metal bonded to the base metal in the form of a ridge or bar.

This *new* method of lamination provides a great advantage to manufacturers of many contact assemblies, in that an arm or leaf can be blanked out with the contact already attached. The precious-metal ridge constitutes a bar-shaped contact.

By specifying the width and height of the precious-metal strip, any electrical current requirements can be met. Costly assembly operations are reduced to blanking costs. The precious metal that was wasted in the shank of a rivet can be saved.

We have standardized on a number of strip widths and thicknesses for both single, double and double-double combinations in "Raised-Lay." We are also prepared to furnish contact material in the form of "Inlay," "Edgelay," and "Overlay." In addition to supplying these materials, we offer a blanking service to your specifications.

Your inquiries are cordially invited.

*Patents applied for covering both the material and the method of manufacture.

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LAMINATED PRECIOUS METALS
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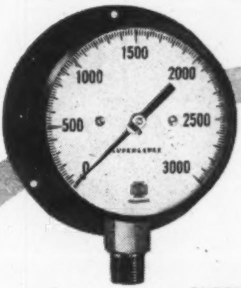
FABRICATED PARTS AND ASSEMBLIES
BAR CONTACT MATERIAL
PRECIOUS METAL SOLDERS

USG HELPS YOU SELECT GAUGES

From the World's Largest Family of Instruments

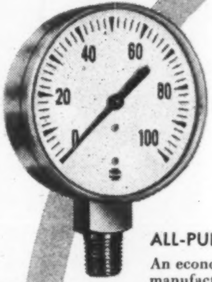


SUPERGAUGE

An instrument of test gauge accuracy, designed for many years of service in heavy-duty industrial installations. Withstands excessive vibration and pulsation and provides a safe positive check on process control.

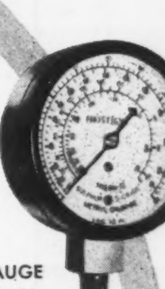
ULTRAGAUGE

A superior quality gauge of top-most accuracy and durability, designed especially for chemical and oil refinery applications. Furnished in 4½", 6", 8½", 12" and 16" dial sizes . . . from vacuum up to 100,000 pounds per square inch pressures.



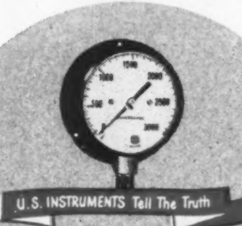
ALL-PURPOSE PRESSURE GAUGE

An economically priced pressure gauge manufactured to commercial accuracy. It has a phosphor bronze bourdon tube and a corrosion-resistant movement. It's smart in appearance and dependable in performance.



REFRIGERATION GAUGE

Important features include: adjustable hub pointer, broad easy-to-read luminous dial, removable screw check. Low side gauge has 1" and 1 lb. graduation and is protected to 200 lbs. overpressure. Also available with external calibrator and retarded movement.



6 out of 10 Manufacturers Buy US Gauges

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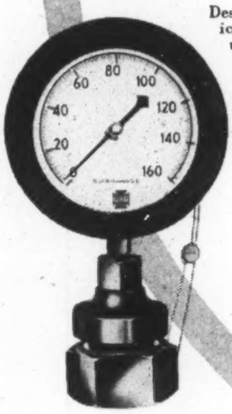


CHEMICAL GAUGE
Clean-Out Type

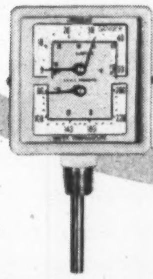
Designed for service in chemical and processing plants for use on heavy viscous fluids that tend to clog. Supplied with precious metal diaphragms and assemblies for highly corrosive chemical application. Diaphragm is easily removed for cleaning.

HYDRAULIC GAUGE

A gauge built to give continuing and accurate measurement of hydraulic pressures. The extra heavy-duty movement is designed to withstand the severe shocks and rugged service required of gauges when installed on hydraulic presses and Diesel engines.

BOILER GAUGE

For use on hot water heating systems. Indicates on one dial: water temperature, head of water above gauge and pressure in system. Rugged construction with easy-to-read dial. Available in round or square case.



WELDING GAUGE

This well designed gauge incorporates the safety blowout features in the low as well as the high pressures. It is especially designed to withstand rugged handling. It is a tough gauge for a tough job.

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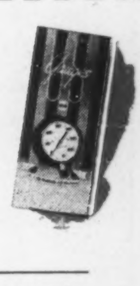

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ALUMINUM
WELDED STEEL

PRODUCTION FLARING

LEAKPROOF JOINTS FOR LIGHT WALL TUBING

- ★ Long, smooth 10° flare provides greater sealing surface. No shearing action; tubing is actually strengthened.
- ★ Only single flare needed for any tubing.
- ★ Up to 2000 flares a day on inexpensive flaring machine.

Superseal FLARED TUBE FITTINGS

Approved by Underwriters' Laboratories for all hazardous gases and liquids.

HAS YOUR DESIGN THINKING shied away from light wall tubing applications when *vibration and high pressure* were present? It needn't if you specify Superseal fittings. The Jaeger Mfg. Co. tested these flared tube fittings exhaustively. One of the tests was on a gasoline engine driven compressor, which was run at full throttle for six hours at 600 p.s.i. They were convinced that Superseal fittings make a leakproof joint unaffected by vibration, perform entirely satisfactorily with welded steel tubing using only a single flare. As a result, Jaeger now standardizes on Superseal fittings for 4 compressor sizes.

Investigate Superseal fittings. Write for new Catalog 4-R, "Grinnell Superseal Flared Tube Fittings".

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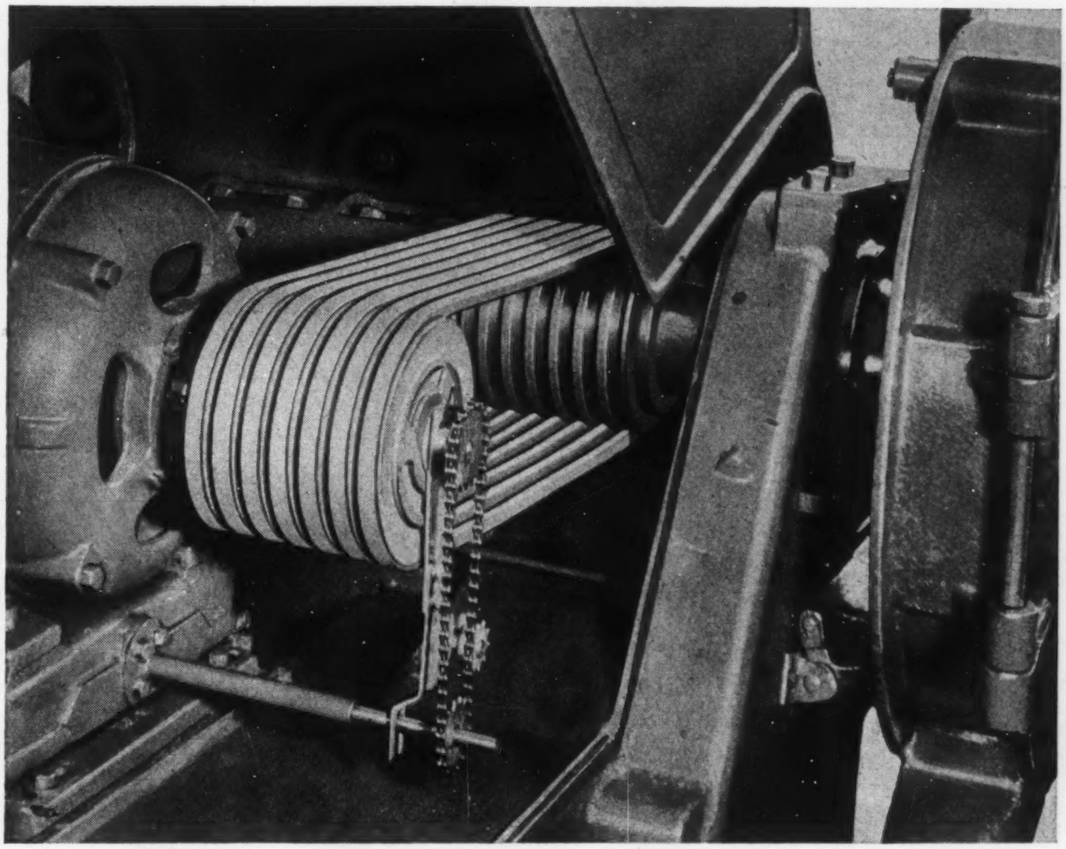

Texrope *VARIABLE* Speed Drive ... the practical way to get Accurate Speed Control

- To regulate a machine tool to suit variations in job, material, or individual workman
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- To vary the speed of a pump, spinning frame, conveyor, rock crusher or grinding wheel
- *Wherever* the ability to change operating speeds at will can add to efficiency, output or economy —

Install Texrope Variable Speed Drives!

These flexible drives use economical constant speed motors. They provide infinite speed variations within their ranges — quickly, easily, accurately.

Vari-Pitch sheaves using A, B, C, D or E belts are available for stationary or motion control, with range up to 25% per sheave; *Vari-Pitch* sheaves using Q or R wide belts allow variations up to 100%; *Vari-Pitch* speed changers permit ranges up to 375%. There are types and sizes to suit all needs, from fractional to 300 hp!

Texrope offers the *most complete* line of variable speed drives made ... engineered and built by Allis-Chalmers, originator of the multiple V-belt drive. See Sweet's Catalog, or call your nearby A-C office or dealer for Bulletin 20B6051G. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

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"Super 7" V-BELTS
Five Types — Sizes to suit every power transmission job.

Texsteel, Texdrive, "Magic-Grip"
— sheaves in a full range of sizes, grooves.

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Exact variations in speed, stationery or motion control.

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Speed variations up to 375% at the turn of a crank.

ENGINEERING
Finest V-Belt engineering talent in the world—at your call.

TEXROPE "Super 7" V-Belts result from the cooperative research of two great companies — Allis-Chalmers and B. F. Goodrich. They are sold only by A-C.

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One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products

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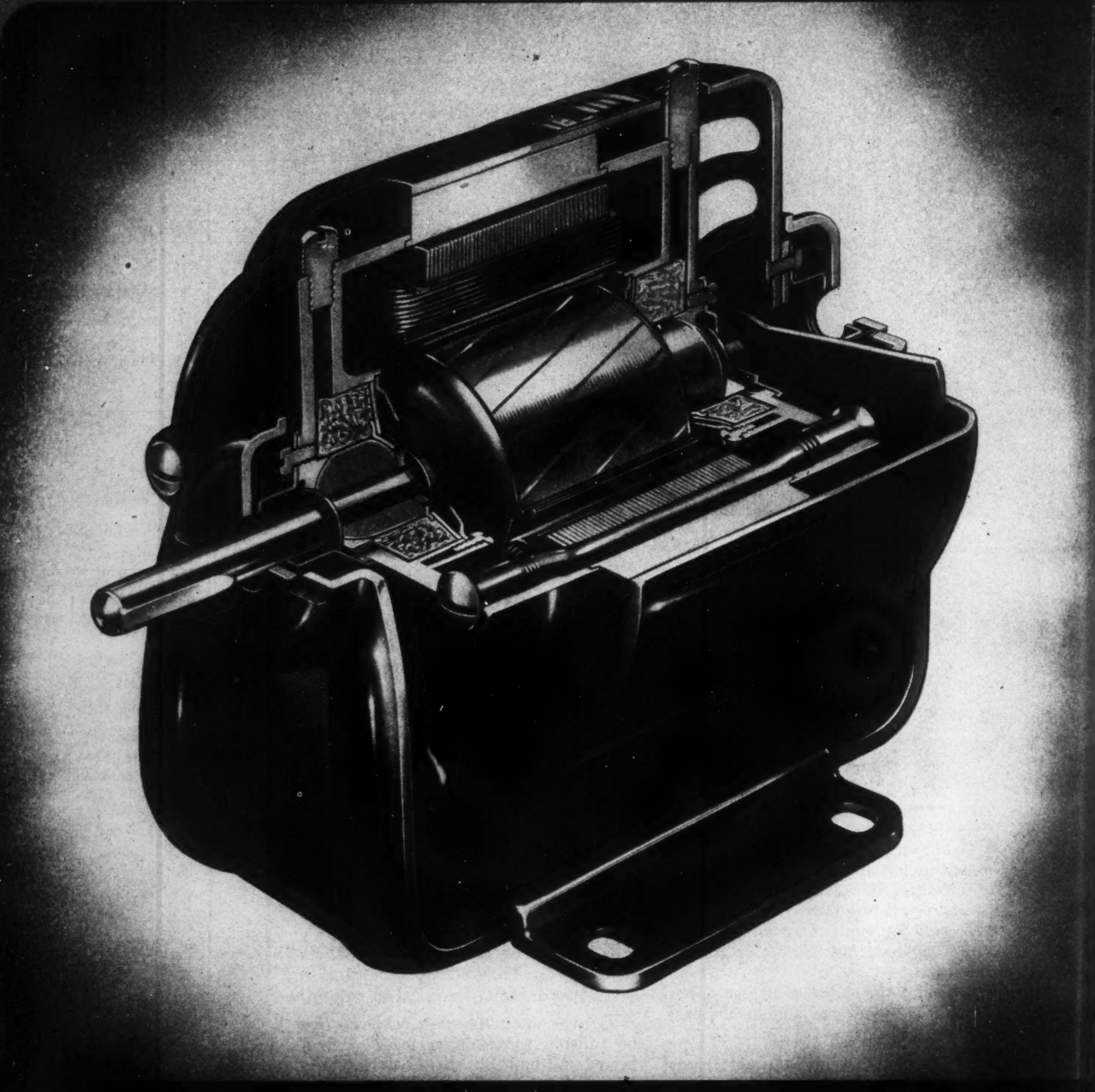
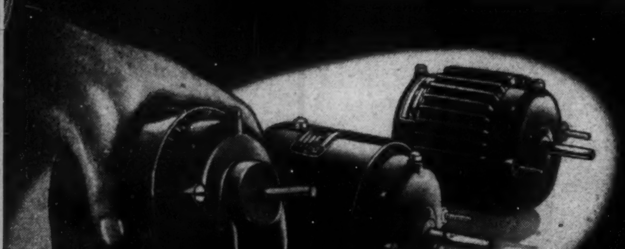
A CENTURY OF SERVICE
to Industry
THAT MADE
America Great

Sound Foundation —





THREE BASIC TYPE "T" MODELS . . . The T-110 shown at far left has a rugged pressed steel base and is cushioned in generous rubber pads. Shown next to this, without a base, is the T-123. Both of these models are provided with Air-Stream enclosed fan cooling and can be used for general duty up to 1/30th horsepower. For fan duty they handle 1/25th horsepower loads. To the right of the T-123 is the T-121 built with exposed cooling fins. It provides up to 1/25th horsepower for fan applications where airflow is directly over Micromotor.

Wichita City Library

FOR ELECTRICALLY POWERED PRODUCTS

TYPE "T" A. C.

Redmond

MICROMOTORS

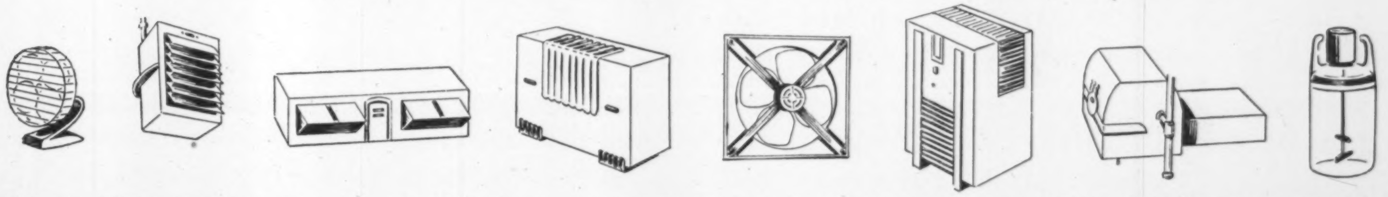
TAKE a good look at this sturdy 1/25th horsepower job. Don't miss that husky frame. Check the precision construction of its famous Flush-Weld rotor. Measure off the solid footing provided by large bearings spaced 3½" overall.

You'll find this fine Redmond Micromotor retaining accurate alignment throughout thousands of hours of steady service. You'll find it well suited for tough use on full rated loads.

Here is sound engineering. Redmond Type "T" Micromotors are products of more than 20 years of specialized experience in the building of 20,000,000 low range fractional horsepower motors.

Build your motor-powered products on a sound foundation. If it's a twenty-fifth horsepower you need, check the fine Type "T" Micromotors. Other Redmond A.C. Micromotors are made in sizes from 1/150th up to 1/15th horsepower.

Illustrated below are just a few of the many applications for which Type "T" Micromotors are ideally suited:



Air Circulators • Unit Heaters • Window Type Ventilators • Air Conditioners • Wall Type Ventilators • Space Heaters • Gas Burners • Churns

Redmond COMPANY, INC.

Main Offices
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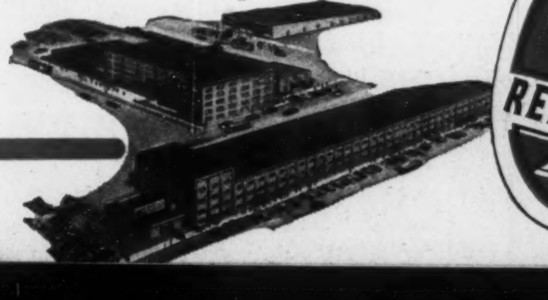


REDMOND

Redmond facilities include 2500 employees and more than 5 acres of floor area.

Topics

MORE MAGNETISM than possessed by any other alloy practical for use in motors and generators is carried by a new 35 per cent cobalt, 64 per cent iron and 1 per cent chromium alloy. Developed by Westinghouse and known as Hyperco, the material is tough enough to withstand intense vibration and will make possible the design of equipment 10 per cent smaller and lighter.

ELECTROPOLISHING solution for finishing stainless steel consists of glycolic acid, sulfuric acid and water. Announced by the DuPont Co. The polishing solution remains liquid at room temperature.

EXTRUDED TUBING of stainless, special steel and nickel alloys may be produced from a solid billet in only a few seconds during which time no change in temperature takes place. The only commercial high-temperature metal extrusion plant in the country is operated by the International Nickel Co.

INDUCTION AND DIELECTRIC heating equipment manufacturers have formed a new section in NEMA to insure greater benefits to the user of high-frequency heating equipment.

CROSS-WIND landing wheels for transport planes, similar in design to those developed for light planes, will have the maximum degree of caster that can be built into the wheels without modifying the structural design of a landing gear. One-strip fields will be practical because the landing gearcasters sufficiently to counteract the wind component at right angles to runway heading.

MEASUREMENT of high vacuum is facilitated by two types of gage tubes developed by RCA. One is a thermocouple type with heat applied to two crossed wires of dissimilar metals. Temperature attained in the wires depends on the heat conductivity of the gas remaining in the vacuum and thus is a measure of the vacuum. The other is a "Pirani" type tube containing a fine filament connected to one arm of a Wheatsone bridge. As the heat conductivity of the gas changes with pressure, the temperature and resistance of the filament changes, unbalancing the Wheatsone bridge.

ELECTRONIC METAL DETECTORS are being used to advantage for disclosing contaminations in foodstuffs in process of manufacture. When used as an inspection device they may light a lamp, sound a signal, stop a conveyor, mark the contaminated material, or deflect it into a chute for rejects. The devices also provide protection against machinery, die or mold damage.

INSULATING MATERIAL, known as Santocel, produced by Monsanto consists of 6 per cent silica and 94 per cent air and is twice as efficient as common insulating materials.

STEEL PRODUCTION of 80 million tons during the past 12 months is 15 milion tons higher than the best previous year when there was no war influence at work, according to Walter S. Tower, president, American Iron and Steel Institute.

NEW STANDARD, entitled "Limits and Fits for Engineering and Manufacturing" (American Standard B 4.1-1947) is expected to serve as a guide to machine designers in keeping to a minimum the various tools and gages required to produce and inspect cylindrical holes and shafts or other component parts with cylindrical external surfaces. Included is a table of sizes for holes and shafts.

CO-OPERATIVE RESEARCH and engineering between the petroleum and automotive industries will lead to greater fuel economy in motor vehicle operation. According to C. F. Kettering, high-compression engines giving from 33 to 40 per cent higher economy than today's automobile engines have been in operation since last November.

NO SCORE!

ONE of the chief trouble spots on a lathe has always been the ways. Constant carriage travel wore out integral ways, shortened the life of the machine tool. And even replaceable ways made of the costliest steels scuffed and scored. Result—poor quality of the machined product.

One machine tool maker set out to find an answer. His search led him to The Timken Roller Bearing Company and 9114 0—a remarkable graphitic alloy steel developed by Timken metallurgists.

The presence of free graphite in its structure, together with diamond-hard carbides, gives 9114 0 stubborn resistance to wear and a unique ability to retain lubricant.

When the manufacturer tried 9114 0 for his ways he could hardly believe the results. No scuffing or scoring. Easier action of the carriage. And such stubborn resistance to wear that today 9114 0 ways often outlast the useful life of the machine itself!

And that's not all! 9114 0 machines 25% to 30% faster. It offers uniform response to heat treatment. Yet the tool manufacturer found it far more economical than the steels formerly used.

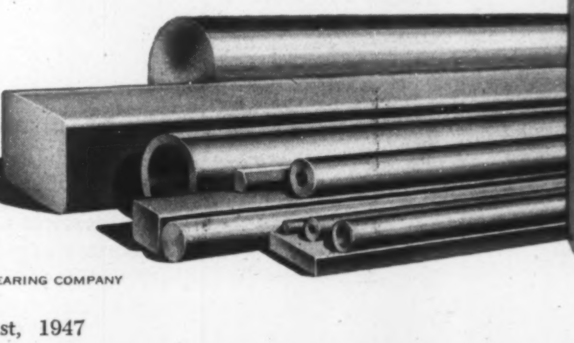
This is just one of many tough problems that can be stamped: "Solved—by Timken Alloy Steel." It's a record no other steel producer has equaled.

If you have a steel problem, why not write Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio. Tapered Roller Bearings, Alloy Steels and Seamless Tubing, Removable Rock Bits.

ANOTHER PROBLEM
SOLVED
BY
TIMKEN ALLOY STEEL

See us at the
MACHINE TOOL SHOW
Machine tool ways of 91140 will
be on display in our exhibit
Spaces 317-D and 317-H

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



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Fine Alloy
STEEL
and Seamless Tubes

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MACHINE DESIGN

Autoclave Design

. . . illustrates the key factors incident to any type high pressure, high-temperature vessel or enclosure

By Charles A. Long
Manager, Process Equipment Division
Struthers Wells Corp.
Titusville, Pa.

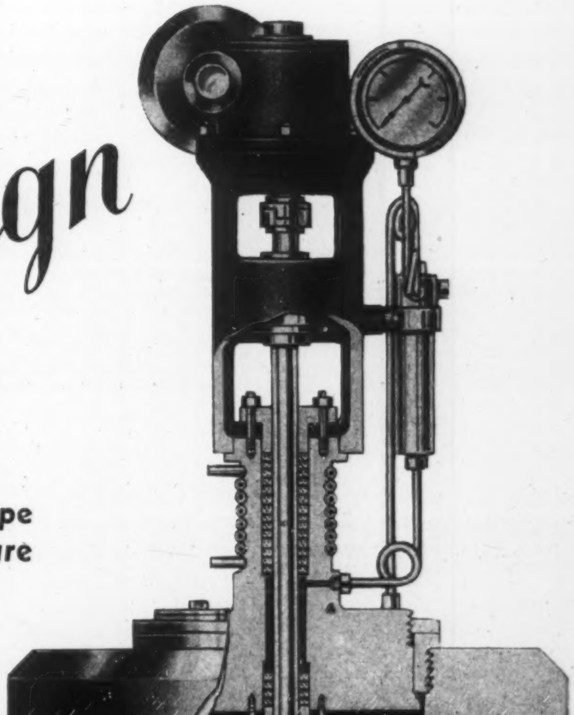


Fig. 1—Pilot plant autoclave designed for handling process liquids at high pressures and temperatures

GENERALLY speaking, the term "autoclave" commonly includes a large group of pressure vessels employed both in the industrial field and in the realm of research. A strict interpretation of the word autoclave, however, would define it as a heated pressure vessel for carrying out chemical reactions, involving the use of liquids, vapor pressure from which is developed by rise in operating temperature. This article will cover particularly the design of high-pressure laboratory autoclaves, *Fig.* 1, and, generally, larger units required for actual industrial application along with the various design problems incident to satisfactory and safe operation. Parallel problems encountered in the design of other machines subject to high pressure, high temperature and chemicals will be readily recognized.

GENERAL REQUIREMENTS: Fabrication of pressure equipment in the United States is governed by the rules of the ASME code. In some states where these requirements are not mandatory, it is desirable to build equipment according to code rules as far as applicable and subject to approval and inspection by insurance company surveyors available for this service. Such inspection and supervision of fabrication permits insurance coverage and protection for the user. However, the

ASME code covers pressure vessels for working pressures up to 3000 psi only. Vessels exceeding this pressure cannot be code stamped, but should be fabricated as closely as possible to the code rules.

Design Logic: For calculation of wall and head thicknesses of pressure vessels, conventional ASME code formulas are applicable, except when the wall thickness becomes greater than one-half the radius of the vessel, in which case the Lame formula most generally used for heavy-wall vessels would apply. These formulas are readily available in code and pressure vessel handbooks.

Safety Factor Based on Practical Limitations

A safety factor of five usually is used to determine the working stress, but when pressures greatly exceed 3000 psi it is necessary to reduce this safety factor governing the permissible working stresses. Application of the Lame formula in designing an 8-inch diameter vessel (operating pressure 10,000 psi, safety factor of five, and working stress 14,000 psi) for instance, produces a wall thickness that is excessive. Even an infinitely heavy wall will not prevent a vessel from failing if the internal pressure is greater than the ultimate strength of the material. Consequently, to provide a practical wall thickness, higher working stresses must be employed and it is permissible to reduce the allowable safety factor. As design pressure rises, the factor can be reduced to four or three and, with high pressures over 25,000 psi, it may be necessary to reduce to two. Such low values involve other considerations such as the particular method of hydrostatic testing, the use of autofrettaging and other precautions covered elsewhere in this article.

Where welded construction is to be used, the highest class of welding covered by U68 rules of the ASME code should be specified. This requires stress relief and x-ray of all welded seams to assure perfect joints. In such construction, the low-tensile steels suitable for welding must be used, which naturally limits the allowable working stress for design.

Seamless vessels, being forged, may utilize high-tensile alloy steels since no welding is involved. These should be made from ingots or billets with a reduction of about three to one to assure quality results and proper preparation of the steel. Necessary heat treatment is determined by the particular equipment application and governed by the alloy steel selected. High-tensile values may thus be obtained to permit the higher working stresses necessary in the operation of the high-pressure vessels.

The autofrettaging process of preparing forged vessels for high-pressure work over 40,000 psi was developed a number of years ago to improve the quality and service life of gun barrels particularly and consists essentially of applying hydrostatic pressures of from 40,000 to 100,000 psi to the interior. By this system the steel of the forging is stressed beyond its elastic limit so that a permanent growth in size results. Indicators are used to observe carefully and record this stretch by micrometer readings during the test. Any indication of stretch beyond predetermined values would indicate defective steel and therefore would be dangerous under such pressure.

A small allowance of metal is made in the bore so that after testing, the vessel can be finish ground to the final dimensions. This method of cold working the vessel bore increases the proportional limit and tensile strength of the metal, the change being greatest at the bore and decreasing to the outside of the vessel wall. A heat treatment or soaking is given before final machining.

There is some use and application of high-pressure bodies made of cast steels, including carbon steels and corrosion-resistant steels such as stainless, chrome, etc. They are generally avoided in the higher pressure ranges, however, particularly because of casting defects which often occur, requiring replacement and therefore additional cost. Castings of Hastelloy alloys often are desirable and have been successfully used for certain problems of corrosion resistance. Sometimes it is economical to provide

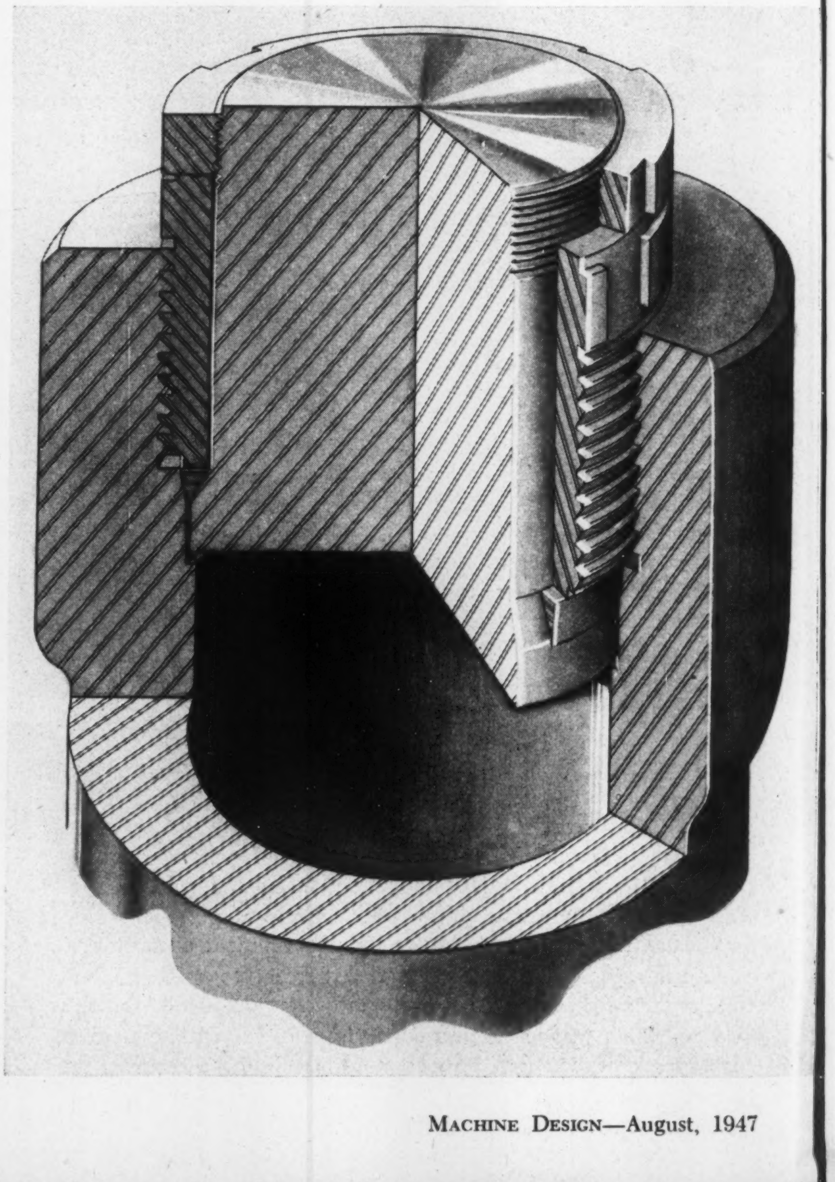
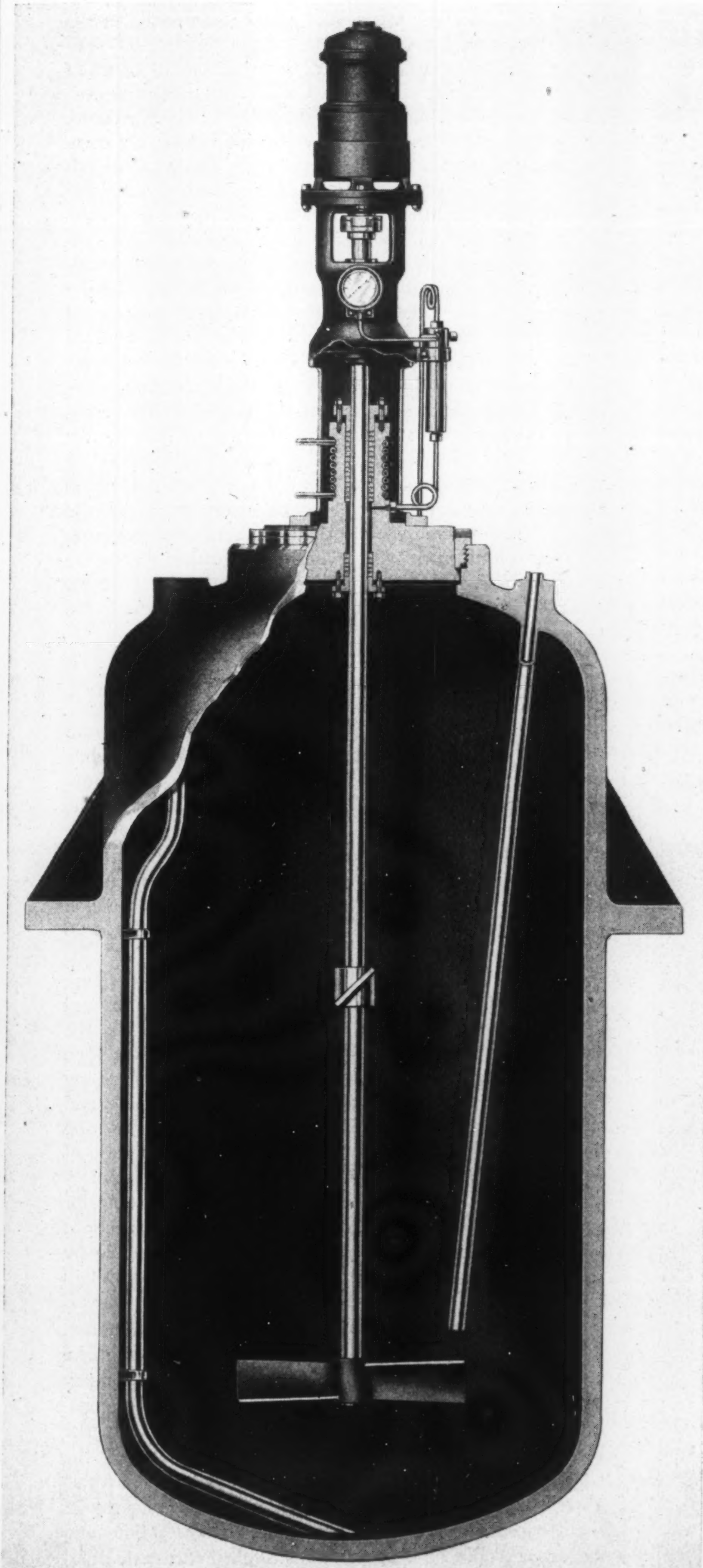


Fig. 2—Right—self-sealing closure for pressure vessels utilizes internal pressure to load the seal



a combination of several forgings welded together or a combination of castings, forgings and plate.

In designing enclosures for the higher pressures and temperatures, metal seals must be employed as a general rule. Dimensional accuracy is highly important therefore and tolerances must be carefully determined. Sharp corners must be eliminated and change in size of section must be gradual to distribute stress as evenly as possible.

Pressure vessel design for temperatures above 650 F naturally must take into account the creep characteristics of the metal used. Generally speaking, creep may be neglected with operating temperatures under 650F. Above this temperature, lower working stresses must be used. It is common practice to build a vessel for working pressure of 10,000 psi at 650F maximum and provide a tabulation of working pressures at higher temperatures in increments of, say, 50 or 100 degrees. Thus at 800 degrees the same vessel can be used with a reduced maximum operating pressure. It naturally follows that a vessel can be designed for a definite pressure and temperature required. It is advisable to limit the creep to 1 per cent for 10,000 hours operation. There is available published creep data on most of the usable steels. For autoclave operation at the higher temperatures, measurements must be taken periodically to determine what enlargement of the vessel is actually taking place. Such measurements may also indicate erosion or corrosion, but in any case the result is the same and the vessel may become unsafe for full maximum working pressure although it would be usable at lower operating pressures.

Materials Must Be Carefully Chosen

Hydrogen absorption, embrittlement and decarburization result with many steels at high pressures when equipment is used to handle certain chemicals and gasses. Loss in tensile strength may be very great and jeopardize the safety of the vessel in a short time. Suitable steels such as chrome-vanadium alloys and those in the stainless group or variations of them must be carefully chosen to best suit the applicable pressure and temperature requirements.

Thermal shock results from heating a cold vessel too rapidly or from the addition of cooling mediums. When the actual wall temperature differential is high, the stresses set up may add to the stress produced by the interior pressure, creating a total value considerably higher than the original calculations which must be considered in evaluating the

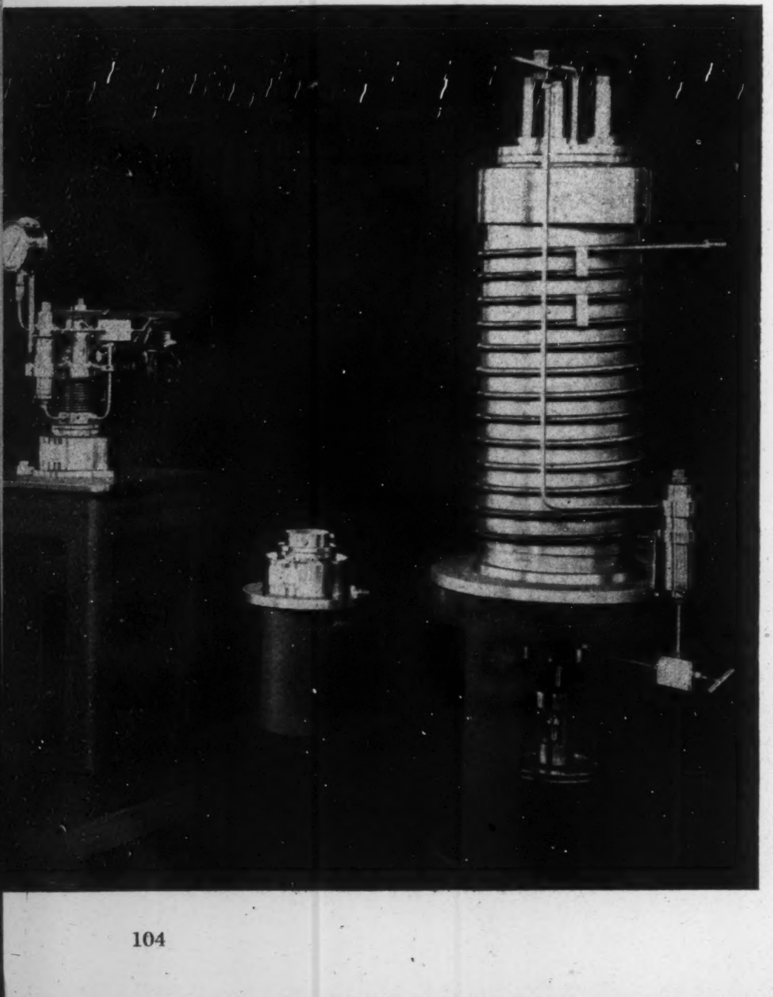
Fig. 3—A 500-gallon production autoclave designed for 2000 psi operation at 650 F

maximum working pressure. The tendency is to restrict such temperature differentials in thick-walled vessels and when heat, either electric or vapor, is applied to the outside, it is good practice to limit the temperature rise per hour to a safe low value to avoid this condition.

In the design of pressure vessels involving the use of different metals, such as one having an alloy-steel body lined for corrosion resistance with stainless, nickel or Monel, the different coefficients of expansion must be taken into consideration. For the purpose of heat transfer it is customary to shrink or press this liner in place. Construction is further complicated by the use of closure parts with different expansion factors. An 18-8 stainless steel, for instance, has about 50 per cent more expansion than does carbon steel. Nickel, Monel, etc., are between these limits, but still must be evaluated. Such combinations are used, but careful consideration must be given to tolerances to provide proper clearances for expansion at necessary points. Again, size is a determining factor, as greater size naturally increases the resulting dimensional expansion. Size may determine the type of closure used as well as many factors of the general design. For example, if dissimilar metals are welded the size will determine the position and type of the weld. When there is a choice of several metals which will be equally resistant and satisfactory for use, the designer has some leeway in avoiding troubles due to temperature expansion.

Expansion which, if exceeded, will cause damage often limits the operating temperature of a vessel. To avoid these conflicting expansion values, it may be necessary to eliminate linings and use a solid metal construction of the desired corrosion resisting metal.

Fig. 4—Below—Three autoclave designs for 5000, 10,000 and 15,000 psi service at 650 F



Pressure Closures: In the low and medium range of pressures it is common to use bolted flange construction. There are definite limitations when the size and pressure are determined as the bolts may become excessively cumbersome and even impossible to design. Gasket materials determined by corrosive conditions may involve excessive bolt pressures, further complicating this type of design.

The screwed type of closure is not so limited and will cover a wide variety of pressures, although limited to relatively small diameters. Numerous seals have been designed including metallic and semimetallic gaskets of many types. In *Fig.* 2 is illustrated a screw type of closure utilizing a "V" metallic seal of the self sealing type. The closure is made by screwing down the large nut, making the gaskets seal against the inside of the vessel, while by means of an additional top nut or bolts as the case may be, the cover is pulled upward against the inside of the metal gasket to seal the interior by forcing the cover upward. It is only necessary to make the original closure sufficiently tight to hold low pressure; build-up of pressure within the vessel further forces the cover upward making the seal even tighter. This design however, requires precision machine work to seal the vessel satisfactorily at the low pressure.

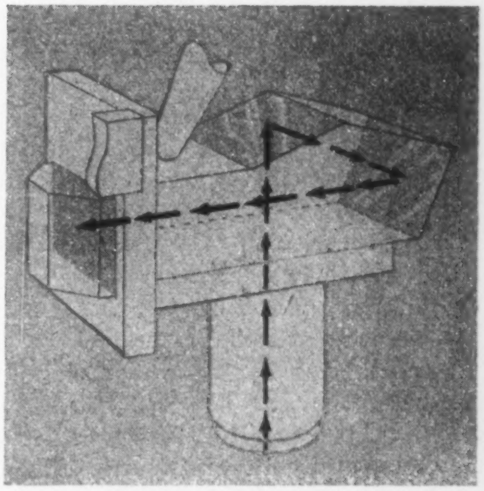
Screwed Closure Widely Used

High pressure within the vessel causes the upper nut to loosen and it must therefore not be tightened while under pressure or it would be difficult to open the closure after pressure is released. Typical adaptations of the construction discussed in the foregoing are shown in *Figs.* 1, 3 and 4. In *Fig.* 3 is a 500-gallon production autoclave for 2000-psi working pressure at 650F maximum. Laboratory and pilot plant autoclaves with ¾ to 25 gallon capacities, *Fig.* 4, have common ratings of 5000, 10,000 and 15,000 psi at 650F.

Valves and Fittings: As with most high-pressure equipment, valves and fittings are necessary auxiliaries and in some cases are difficult to obtain commercially in the sizes and pressures desired. Stainless steels such as type 316 are generally adaptable. Heavy-wall seamless tubing is used in the smaller sizes for high-pressure piping and stainless tubing, ⅜-inch OD by ⅛-inch ID, may be used up to 15,000 psi. Other sizes using an OD to ID ratio of 3 to 1 would be suitable. Cold-drawn stainless and alloy-steel tubing with a diameter ratio of 4 to 1 is usable for pressures to 25,000 psi. The most successful connections are of the tapered cone end type with the seal made by tightening a nut over a ferrule using a left-hand thread on the outside of the pipe itself.

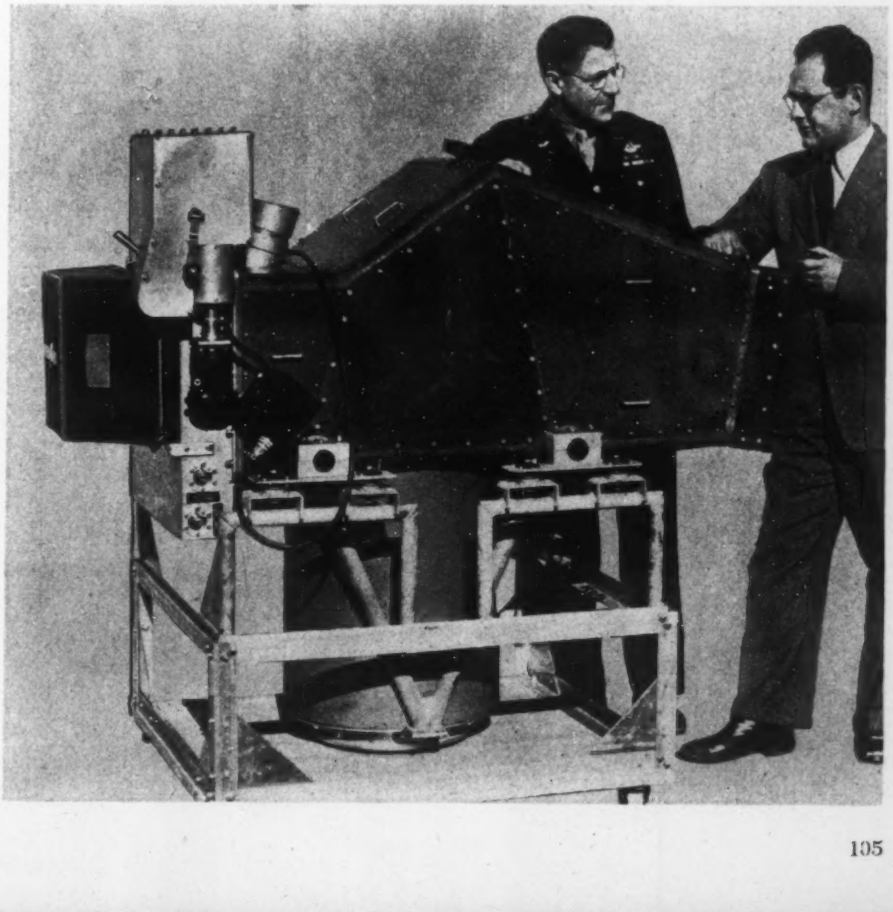
Use and Protection: It is realized that consideration given the many factors covered in this article may make it appear complicated, but it is imperative to cover as many of these points as is necessary in dealing with high-pressure work. Any high pressure is dangerous and the higher the pressure the more dangerous the operation of the equipment becomes. Practically all operations involve gasses under high pressure which naturally, because of their explosive effect, require more consideration and care than would be necessary on straight hydrostatic operation. Explosionproof electrical equipment is a necessity.

Scanning THE FIELD for Ideas

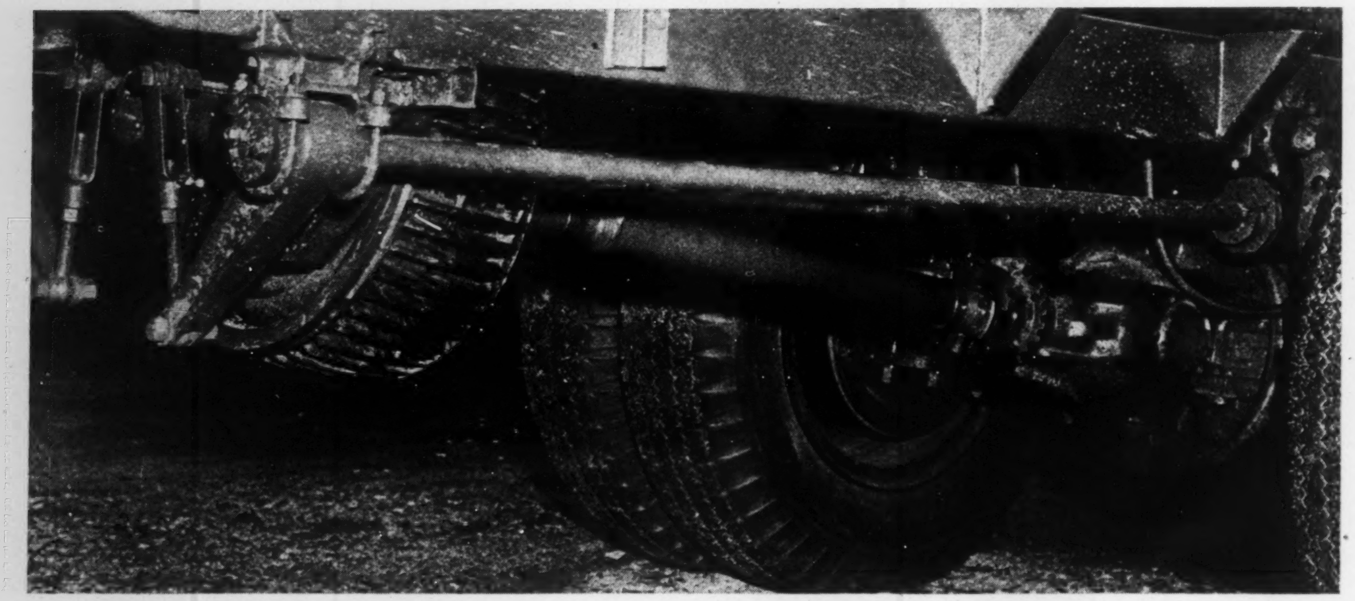


OPTICAL system utilizing two mirrors to "bend" the light after entering the lens in the world's largest aerial camera, below, enabled the designers to reduce the overall size of the camera to a 4-foot height and 5-foot width. If standard design procedures had been followed the camera would have reached the impractical height of 10 feet. Known as the Army Air Forces' K-30, the camera contains a 100-inch focal length, 10-inch diameter lens for aerial photography at 50,000 feet. The light enters the lens, is reflected from the first mirror to the second, and then to the film, completing the 100-inch path in a comparatively compact figure "4" pattern as shown in the diagram at right.

To combat cold weather conditions at extreme altitudes, the camera is equipped with an interior hot-air circulating system, thermostatically controlled, and a large electrically heated blanket which fits over the entire outside of the camera and lens barrel. In operation, the camera's focal-plane shutter has speeds of 1/100, 1/200 and 1/400-secsecond.



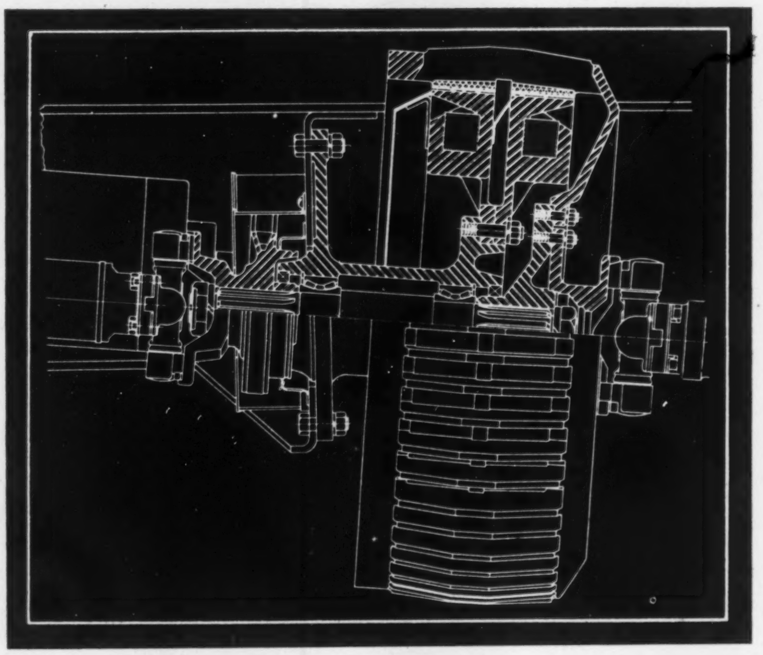
Energy dissipators of the eddy-current type, shown at top of next page mounted on the driveshaft of a trailer truck and in sectional view, have proved a valuable adjunct to wheel brakes for safe transportation of motor freight. Designed by the Warner Electric Brake Manufacturing Co., the dissipator provides its own air circulation for dissipation of energy, as heat, direct to the atmosphere. The housing encloses a V-belt drive to a generator which excites the unit. Speed at which the unit cuts in is controlled by a control knob. After the dissipator cuts in, its torque rises rapidly as the

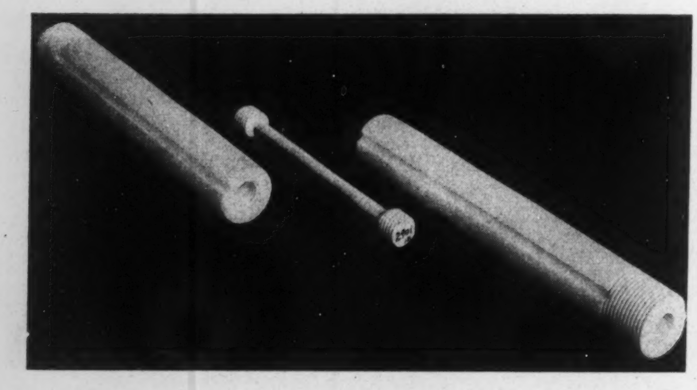


speed increases to a limit established by a voltage regulator to prevent burning out the system. A switch on the accelerator pedal is closed when the pedal is completely released and is opened by a mere touch on the pedal.

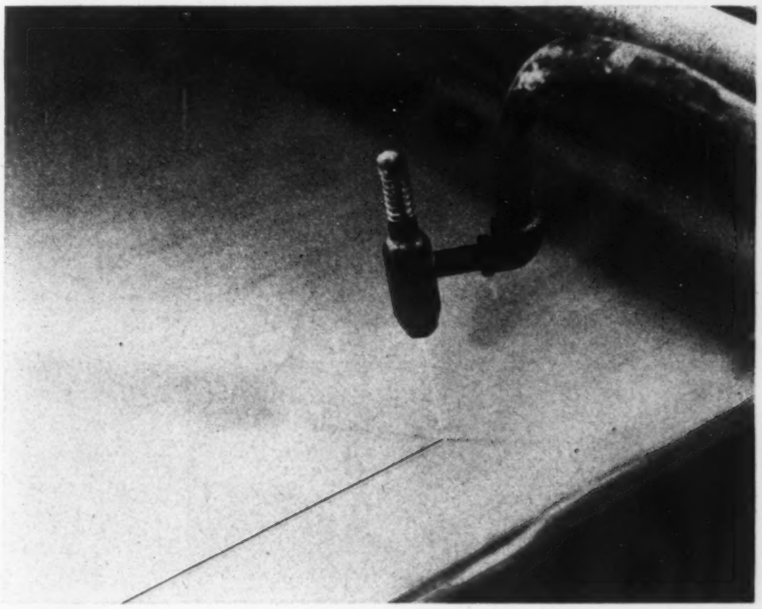
A similar switch on the brake pedal closes when the pedal is touched and the dissipator cuts in regardless of where the control knob is set. When the dissipator cuts in due to release of the accelerator pedal it cuts out again when the unit slows down to a speed slightly below that at which it cut in. When the brake pedal is touched and held, however, the unit cuts in and continues to operate at approximately full torque until the vehicle has slowed down below 14 miles an hour, then it dies out gradually as the speed decreases further. More pressure on the brake pedal brings the wheel brakes into action.

Estimations based on test runs indicate that, with the use of a dissipator, wheel-brake lining life should be about 200,000 miles. Gain in schedule speed as well as safer operation also result.





All-crystalline porcelains, having exceptional mechanical and dielectric strength at temperatures extending up to 2000 F, have been developed at the National Bureau of Standards. Particularly adaptable to applications having sustained loads at elevated temperatures, the composition of these new porcelains is characterized by the absence of silica. Such materials as alumina, beryllia, zirconia, thoria, and minor additions of other metallic oxides are employed. A decided advantage of ceramic materials, if other properties are satisfactory, is their low density as compared with the high-temperature metallic alloys. Shown at left is a test specimen, with test adapters made of the same material. Six types of composition have been tested and all proved highly resistant to deformation or creep at temperatures up to 1800 F for long periods of time. A typical specimen, for example, showed an elongation of 0.23 per cent after a total of 2600 hours during which the applied stress ranged from 9000 to 14,000 psi. At temperatures of 1900 and higher, however, the tendency to creep is more pronounced and appreciably lower stresses produce a creep rate measurable by the hour.



Water-jet edge trimmer, known as a "squirt", shown at right, installed on a Fourdrinier paper machine at a West Virginia Pulp and Paper Co. plant is perhaps the sole method used in the industry for trimming the deckle edge of paper. Water pressure between 80 and 100 psi is employed, depending on the weight of the paper stock being processed, the size of the jet varying from 1/32 to 1/16-inch in diameter. At the stage of the process where the jet is used the pulp mixture on the moving wire is about 85 to 88 per cent water. To trim a clean edge on kraft or heavier types of paper two jet trimmers in series are used, one on each side of the machine. The first makes a partial trim and the other follows with a clean trim. Extremely clean water is required to avoid clogging the jets.

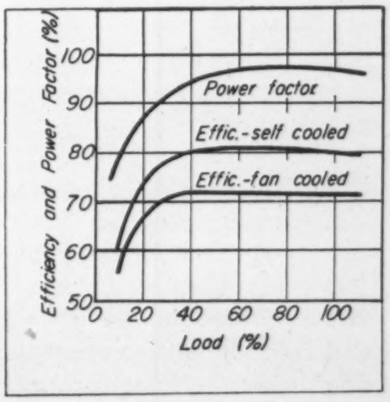
Flame stripping of insulation from enamel-coated wire as shown in the illustration below simultaneously trims the wire to length and, in removing the insulation, leaves the wire sufficiently clean for tinning.

In the system, developed by the Gasflux Co., flux is fed into the fuel gas line to prevent the formation of oxide and soot on the wire. The fluxing ingredients are carried in solution in a highly volatile and inflammable liquid in a fluxing unit. A regulating and bypass valve permits operation with any desired amount of flux. In the unit a cotton wick is kept saturated with the solution so that the fuel gas passing through picks up the flux in vapor form and delivers it to the torch.

Metallic rectifiers, such as selenium or copper-oxide, prove practical for converting alternating current to direct current for operating constant-speed or adjustable-speed motors. Laboratory tests coupled with actual operating experience at the Buffalo plant of Westinghouse Electric Corp. show that, for the range of motor sizes between 1 and 15 horsepower, the cost is less than that for a motor-generator set, efficiency is higher, regulation is essentially the same, commutation is not adversely affected, mounting is simplified, and maintenance is facilitated.

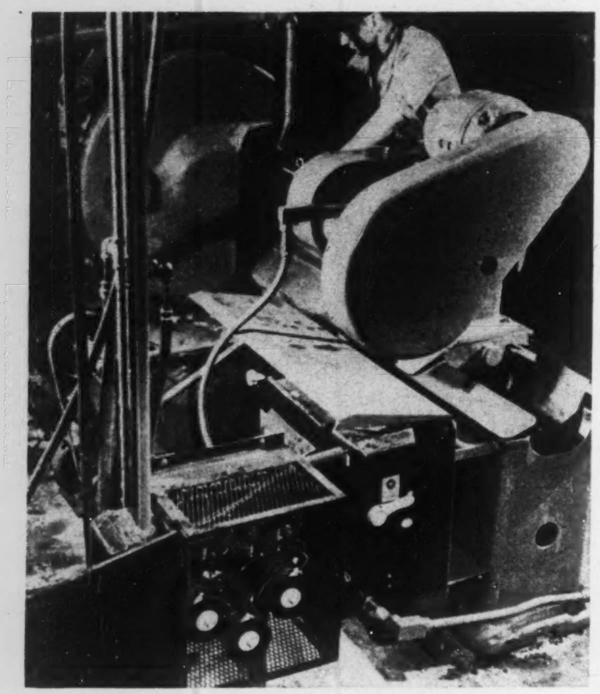
Typical performance curves for selenium-cell rectifiers for operating an adjustable-speed dc motor are shown at right. The lower efficiency of the fan-cooled unit is due to the losses of the fan and the higher load per rectifier cell.

Simplification of the control is possible by taking advantage of the natural internal resistance of the rectifier. In sizes under 7½



horsepower it is possible to dispense entirely with the dc control and retain only the field rheostat.

Shown below is a selenium-cell rectifier applied to a grinder for supplying direct current to the work drive motor. A simple safety switch or magnetic breaker can be installed in the ac line for starting and stopping the motor as it is possible to line start the motor through the rectifier even when the shunt-field rheostat is set to give a speed of four times the base or full-field speed.

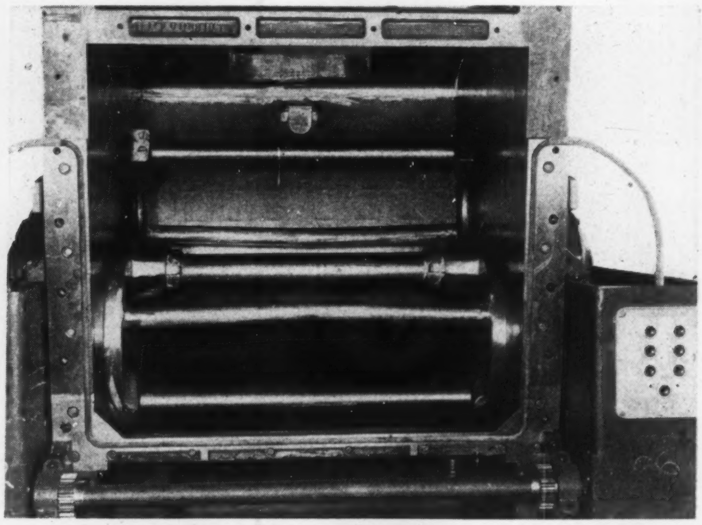


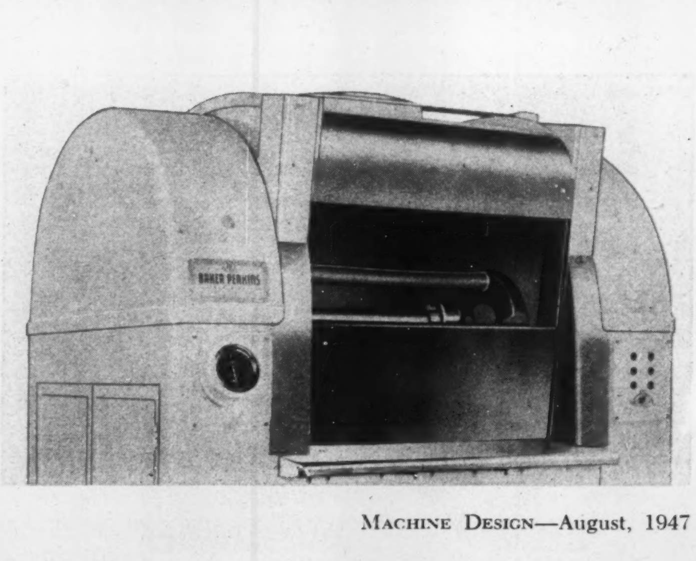
In cases where dynamic braking or reversing is required, a similar simplification of control is possible. This consists of omitting the fluttering relay on the shunt field, as well as the starting resistance and all the relays and contactors associated with the starting resistance.

Hydraulic seal on the sliding door of the Baker Perkins Inc. dough mixing machine, shown at right with the door half open, proved to be the answer to a vexing problem. In order to keep the bottom and sides of the door water-tight, various types of gaskets placed into a groove milled into the face of the mixer bowl were tried without success. If the gasket was pressed tightly enough against the door to be water-tight the gasketing would wear and tear. If the pressure was reduced to a point where reasonable gasket wear could be expected the door would leak. Then it was realized that the only solution would be to release the pressure on the gasket while the door was moving. Various means of increasing the distance between the door and bowl while the door was moving were tried but all proved complicated and costly.

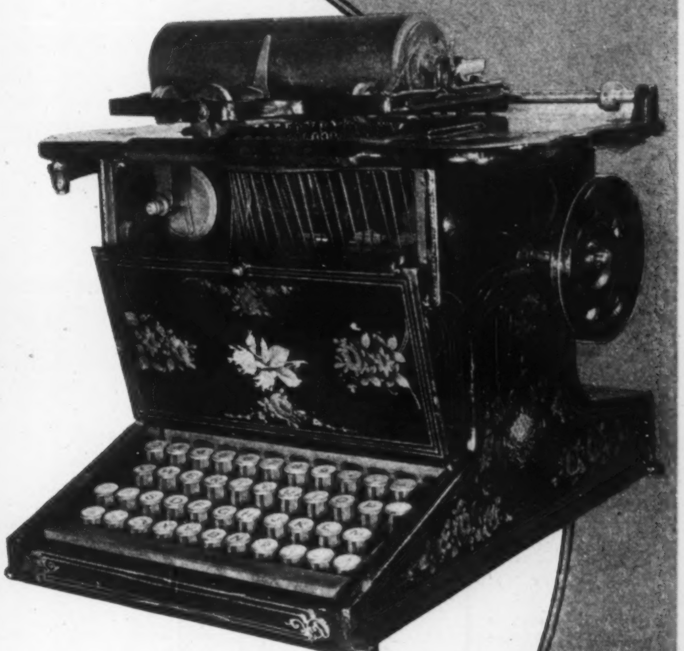
Finally it was decided that it would be simpler to move the gasket rather than the door. This was accomplished by using a Neoprene tubing of approximately rectangular cross section placed in the groove provided in the face of the mixer. The tubing is connected to a source of hydraulic pressure, for instance the city water supply. By means of a 3-way solenoid valve the water pressure is applied to the tubing when the door motor is deenergized and relieved when the motor is energized. In this way the tubing expands to provide a water-tight joint when the door is closed.

Arrangement of the tubing is illustrated in the photograph below with the door removed. The tubing between the solenoid valve and the groove is taped to reinforce it against excessive pressure. The opposite end is equipped with a petcock drain to bleed air from the system. Due to the fact that air is compressible, release of the gasket would be retarded, whereas hydraulic pressure is practically instantaneously released.





design trends



By David F. Welch
Member of faculty
California Institute of Technology
and Industrial Designer

Fig. 1—Above—Typewriter design of 1373-74 is representative of early attempts to beautify machines through the superficial use of ornamentation. Photo by W. W. Morris, courtesy of Popular Science Monthly

APPEARANCE has been a vital factor in design throughout the ages. For thousands of years craftsmen and skilled artisans were trained through long apprenticeships to do most of their own design. Complete familiarity with their materials, techniques and their markets enabled these men to achieve remarkable results in their work.

Today we no longer have this intimate relationship among designer, producer and consumer. The contemporary industrial designer in many cases is called upon to bridge this gap in our economy. It is his part to incorporate in the design all factors which will make a machine or product more attractive to the potential user. He is deeply conscious of proportional relationships in form and is an expert in fully utilizing the inherent beauty of materials. His work is done in close co-operation with the machine designer, preferably from the earliest stages of the design conception.

WITHIN THIS authoritative discussion of designing for improved appearance, the designer will find much that will help him in the development of machines having greater sales appeal, plus increased utility at favorable cost

Competent industrial designers today are doing far more than merely styling or dressing up an engineer's working models. They are actually bringing a thorough consideration of human elements and consumer preferences into machine design. The following discussion will briefly trace the trends in appearance design throughout the machine age and attempt to indicate probable future trends in the ever-changing field of industrial design.

In some of the primitive tools and implements fashioned by prehistoric man are found early evidences of man's appreciation of design. A study of these objects reveals several fundamental factors just as pertinent in design today as they were thousands of years ago. For example, consider three stone axes which are assumed to have the same utility value relative to the cutting edge, balance and other functional qualities. One ax is rather crudely formed and has very little aesthetic appeal. The second ax, no more functional than the first, is a beautifully proportioned, polished piece of obsidian and a true work of art. The third, still no more functional nor beautiful than the second ax, is covered with richly textured carvings.

This simple illustration shows how one tool, implement, machine, or product may function just as well as another and yet not possess nearly the same degree of aesthetic value or visual appeal. It might also be concluded that superficial ornamentation is not a requisite. Finally, it is observed in the case of the carved ax that even early man felt a desire to add ornamentation to an already beautiful functional form. These observations serve to demonstrate the fact that ornamentation or surface treatment can only enhance the beauty of an object when the design is carefully integrated into the surfaces of the form to emphasize the basic form rather than to focus on the ornamentation. *Fig.* 1 shows an early attempt to beautify a machine through the superficial use of ornamentation.

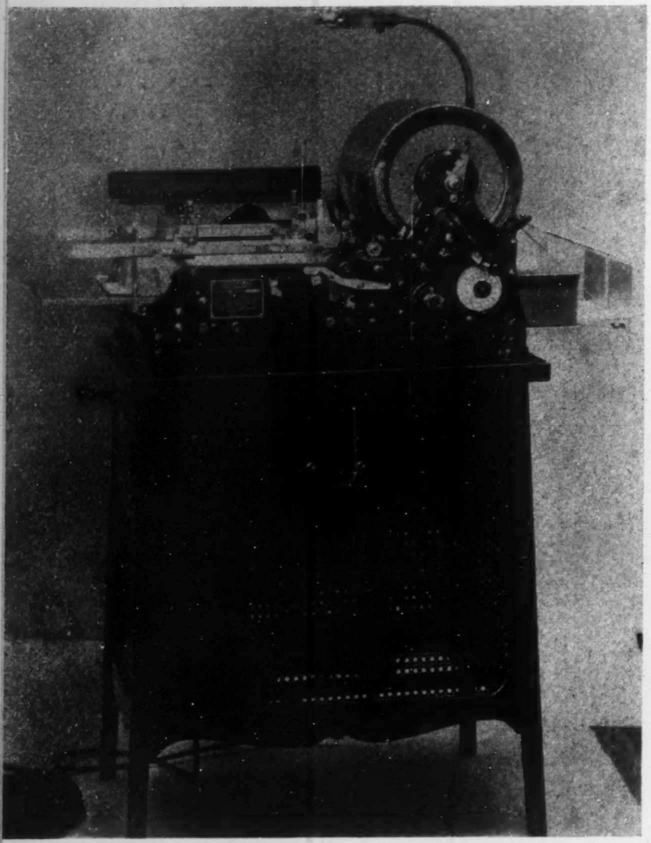


Fig. 2—Above—Mimeograph machine before redesigning for improved appearance. Panel design is confused and many moving parts are exposed, giving a general aspect of forbidding complexity. See Fig. 3 for redesign

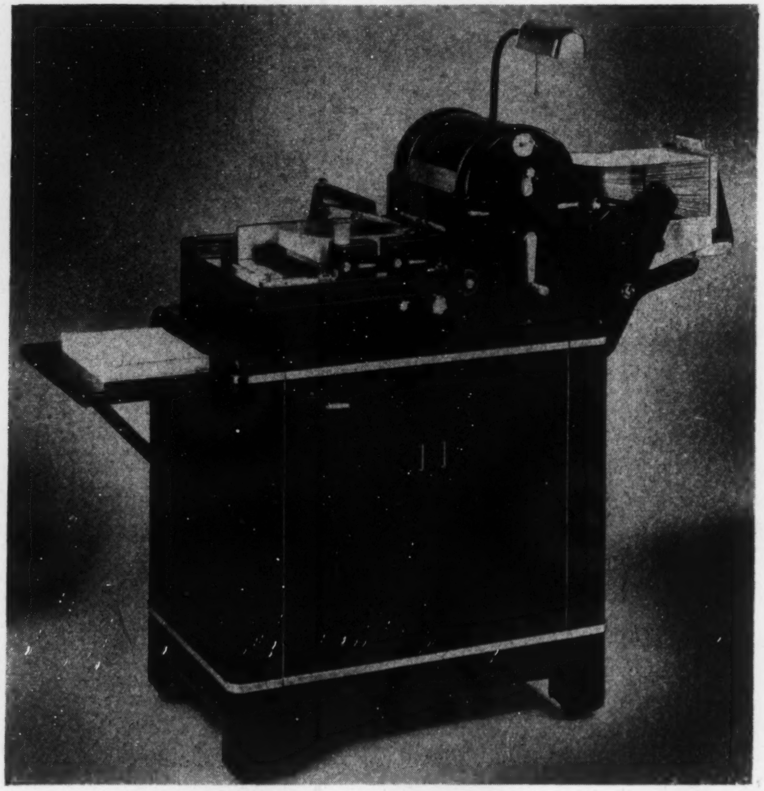
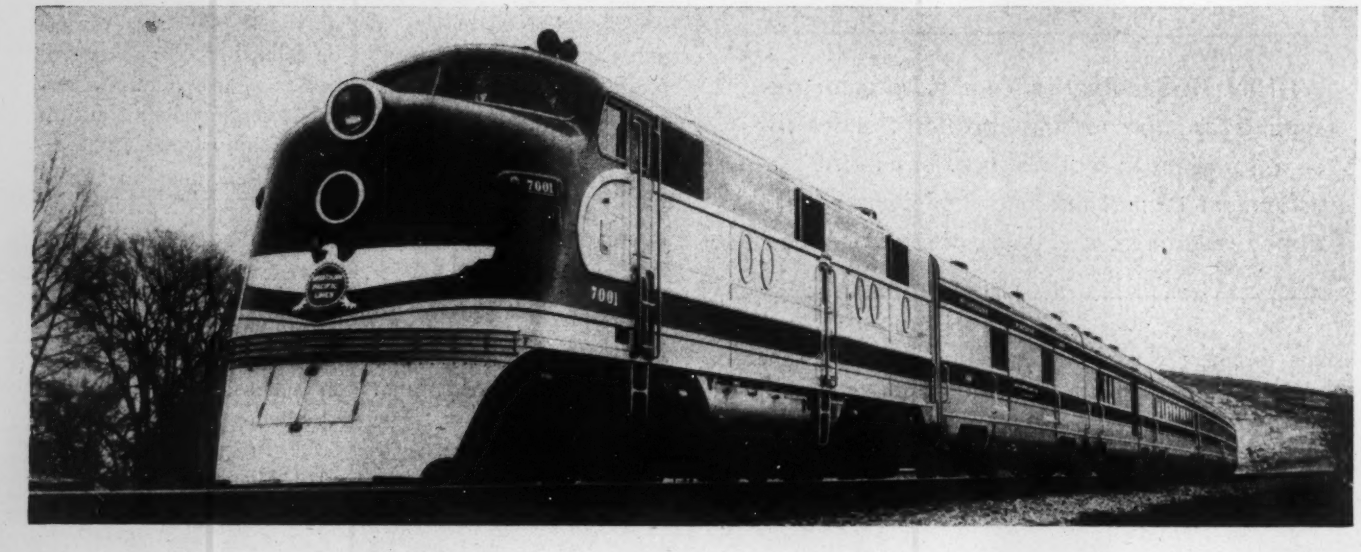


Fig. 3—Right—Mimeograph machine of Fig. 2 after redesign by Walter Dorwin Teague in collaboration with engineers of A. B. Dick Co. Overall symmetry and balance, plus simplified, grouped controls, invites easy mastery

Fig. 4—Below—True streamlining without sacrifice of accessibility is exemplified by Missouri Pacific "Eagle" train and locomotive. Interior design and exterior styling are by Raymond Loewy Associates



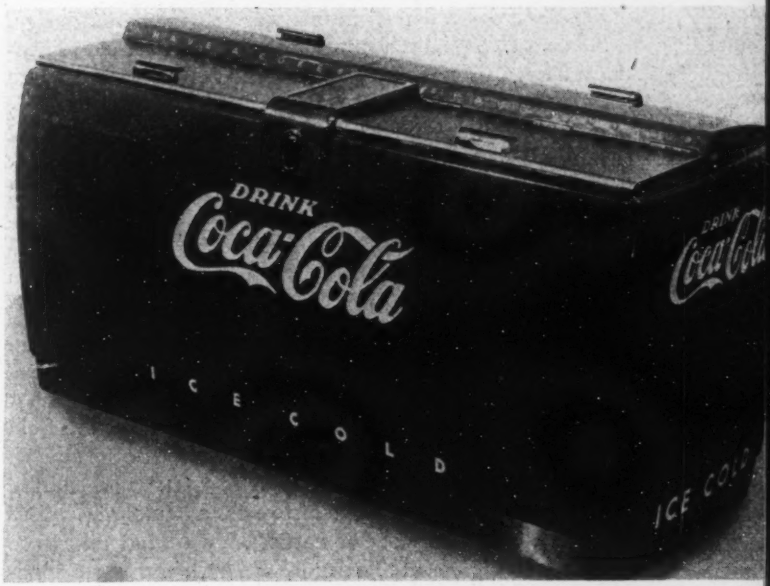


Fig. 5—Right—Slightly convex surfaces of this giant wet electric cooler designed by Raymond Loewy Associates, not only enhance appearance, but also strengthen structure

At the beginning of the machine age, little thought was given to the appearance of machines or their finished products. When the need of considering appearance in design finally was recognized the professional artist was called upon to do the job. His first approach was to apply period ornamentation, which of course produced most incongruous results. The early 19th century beam engine with structural supports designed to look like classical columns is an excellent example of this stage.

One of the earliest organized efforts toward utilizing the aesthetic possibilities in new materials and mass production methods was made by a progressive group of artists, architects and craftsmen at the Bauhaus School in Weimar, Germany, founded in 1918. The first tubular furniture and so called "modern" lighting fixtures were designed and fabricated in quantities by this group.

America did not feel the influence of this group to any extent until the middle twenties when a few manufacturers began to call in artists, sculptors and stage designers to help them improve the appearance of their products. From this phase, the profession of industrial design developed rapidly and today we find a number from this original group as leaders in the field.

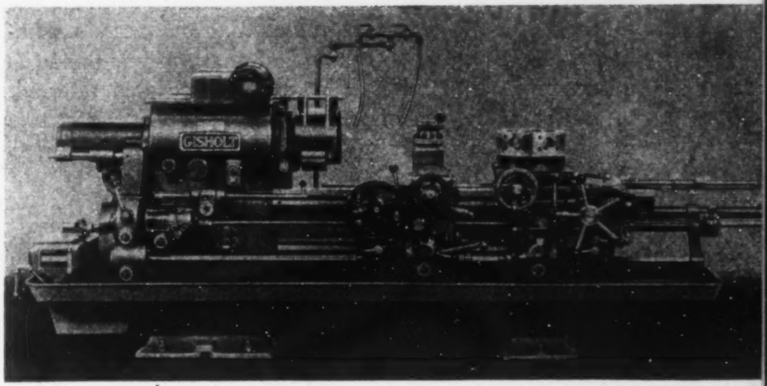
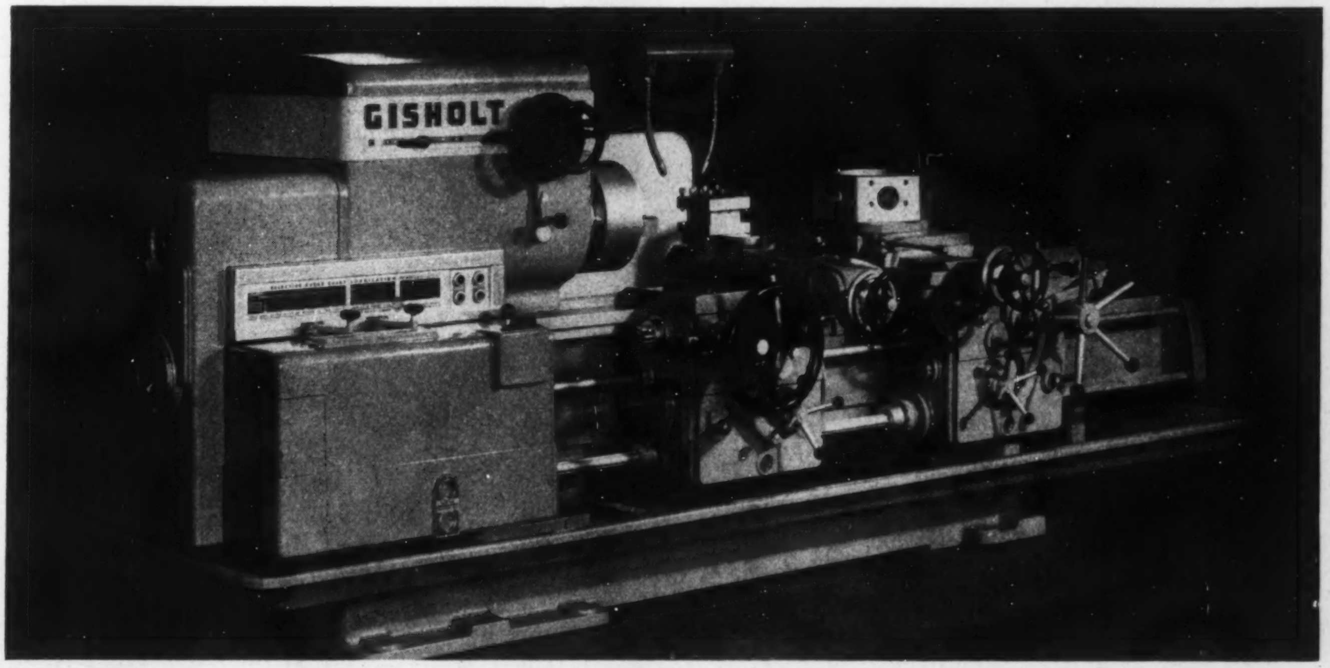


Fig. 6—Right—Turret lathe before styling has superfluity of exposed mechanism, giving impression of extreme complexity and difficulty of operation. (See Fig. 7)

In many examples of products designed in the 1920's and early 1930's there seemed to be a pronounced tendency toward pure geometrical simplification of form. Most of these designs emphasized the interesting use of the qualities and textures of the basic materials being employed. Much of the earlier work done at the Bauhaus and work done in the field of architecture by the inter-

Fig. 7—Below—Turret lathe of Fig. 6 after styling by J. M. Little and Associates gives impression of reliable sturdiness and impels operator assurance. Improved design and location of controls permit easy identification. Operational charts, data plates and gages have been organized for quick, easy reference



nationalists was reflected in this phase of industrial design.

The next step was toward a further logical simplification of form in machine and product design with a much more practical view of the manufacturing problems. This phase marked the beginning of a definite trend toward grouping and housing various previously exposed elements which had been difficult to keep clean and often were a source of danger. An excellent "before and after" exemplification of improved appearance and utility through judicious grouping and housing of components is shown in *Figs.* 2 and 3.

Streamlining Enters the Picture

During the early 1930's new developments in the field of hydrodynamics and the applications of these to aircraft design attracted wide attention. A few designers started a trend toward streamlining airplanes, automobiles, trains and ships with the aims of cutting down wind resistance and simplifying form. The original idea became so popular and so misused that even immobile objects such as radios and electric irons were soon being "streamlined" to the point of appearing ludicrous. The term streamlining originating in this period of pseudo-streamlining is unfortunately still misused by many persons in referring to any simplification of form in the design of a machine or product. True streamlining plus functional styling is illustrated by the modern train shown in *Fig.* 4.

Another trend in styling during the 1930's was the extensive use of wrinkle finishes, chromium strip and bands of lines encompassing an object. Wrinkle finishes provided a very satisfactory solution to the problem of filling small surface imperfections on castings and helped eliminate some of the reflected glare from smooth or polished surfaces, which was highly desirable in certain products. They also provided an inexpensive yet attractive textured surface which offered interesting aesthetic possibilities but had the one disadvantage of collecting dust. Chromium strip, when carefully integrated into the design, made a very successful cover for unsightly joints between various subassemblies in a machine. Again, it soon was being used excessively with the main purpose of dressing up a machine and often was applied without really good taste.

Perhaps the most frequently used motif was the band of parallel lines running around the surface of a product. When used correctly by the designer they may provide extra strength and help prevent warping or distortion in relatively large flat areas of a casting, plastics molding or sheet metal part. At the same time they may help to unify the basic design. These bands, wrinkle finishes, chrome strip and pseudo-streamline forms have been accepted by many as symbols of industrial design and their use greatly abused by the untrained designer.

Two other important trends originating in prewar designs are slightly convex surfaces used in contrast to a plane surface, *Fig.* 5, and the subtle V-ridge used to relieve the monotony in a large surface area. Both of these treatments also have the advantage of a slight stiffening effect in large expanses of sheet metal and are being utilized nicely in some of our postwar product designs. Nearly every new trend in design can be traced

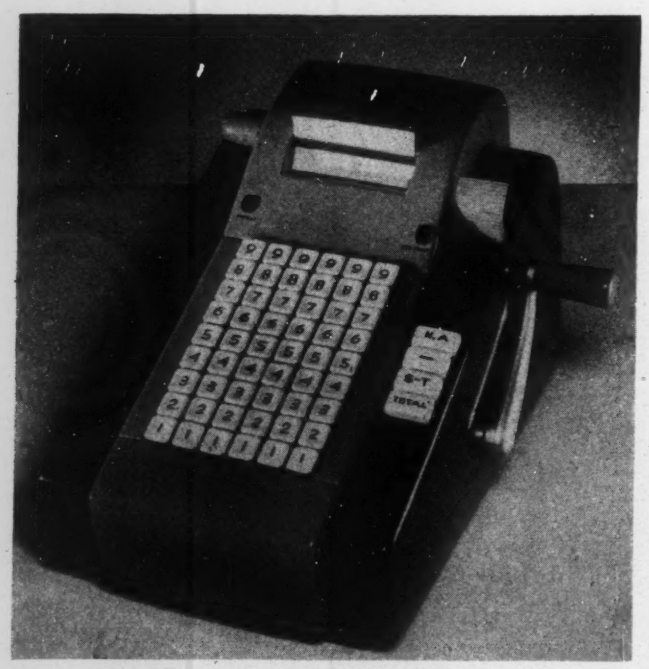


Fig. 8—Keys of this adding machine have sides finished in color which contrasts with tops to emphasize depressed keys. The inset pedestal base provides grip for lifting and also gives effect of lightness. Designed by Industrial Design Associates in conjunction with engineers of National Machine Co. (Ellinwood Industries)

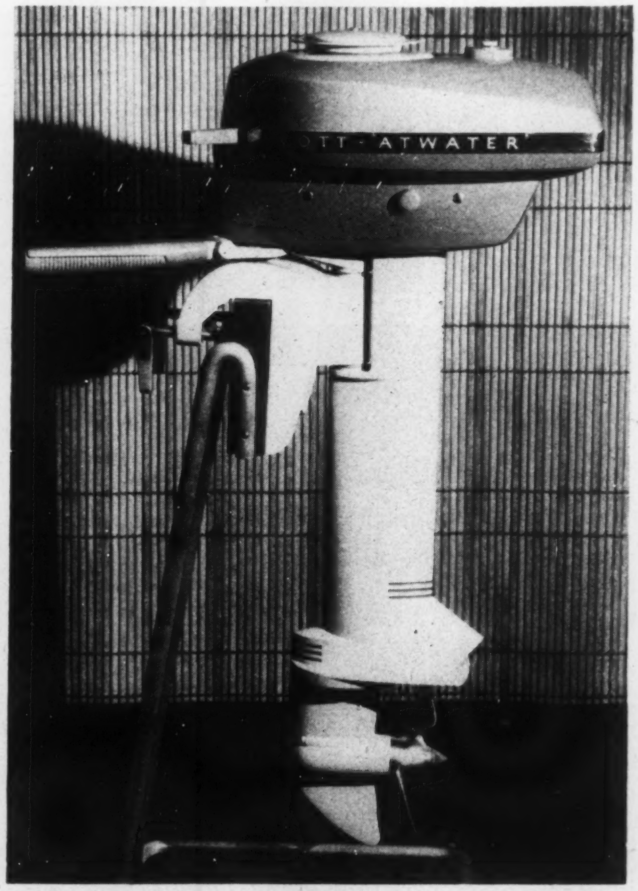


Fig. 9—Clean lines and well-balanced proportioning are exemplified by outboard motor styled by Francesco Collura

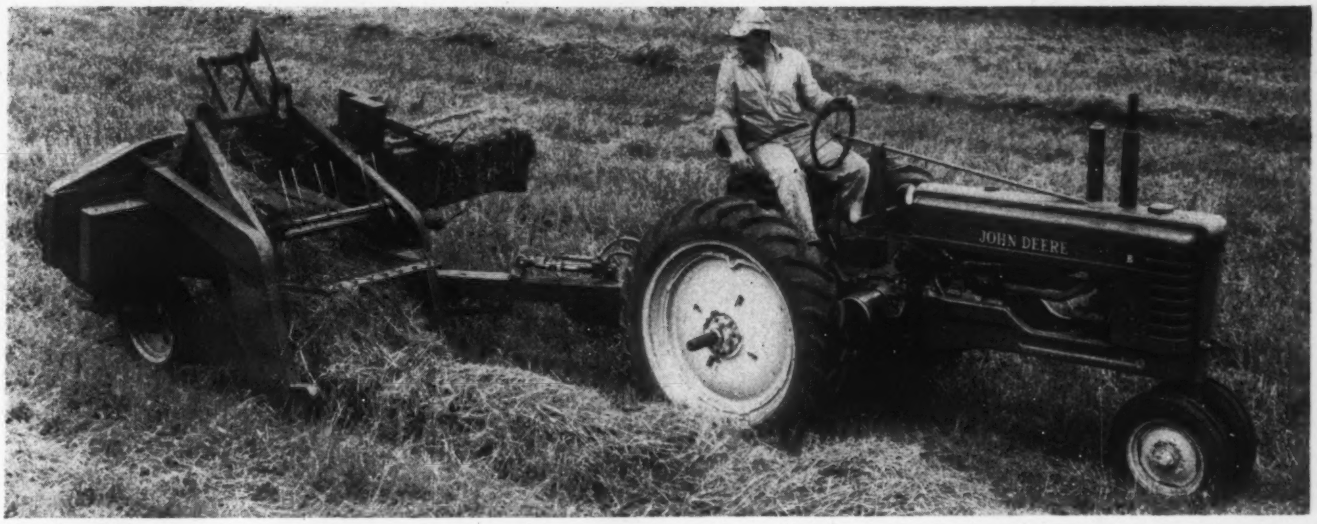


Fig. 9—Tractor and hay press designed by Henry Dreyfuss in collaboration with engineers of John Deere and Co. keynotes simplicity and utility. Clean-cut appearance has been achieved without sacrifice of accessibility

back to the work of some one designer or a single product in which the identifying features of this trend were particularly well handled.

During the war years tremendous strides were made in the development of new materials, new techniques and new facilities for production. Each of these factors will have a very definite effect on design. Critical shortages in certain materials made it necessary to substitute others or even to develop suitable new materials. In many cases these substitutes have proved more satisfactory than the originals. Strict regulation made it necessary to eliminate unessential frills such as superfluous chrome strip and pure ornamentation. From the appearance standpoint the result was often a much cleaner design. Among the purely functional machines and instruments developed for the armed forces are many beautiful examples of effectively simple design.

The Present Trend

At the present time there seems to be a definite sales reaction against pure functional simplicity in some lines of consumer products. The consumer apparently is desirous of more bright chrome, fancy engraved plastic nameplates and other items which have been missing for so long. There is no denying the sales value of these decorative features and the reaction against the simplicity of wartime products is a natural one, but one which sometimes is overrated by the salesman. Fancy trim, if carefully handled in the design, may enhance the beauty of the product. It does add to the cost without improving in any manner the utility of the product, yet it has been used many times to make a deluxe model out of a standard one.

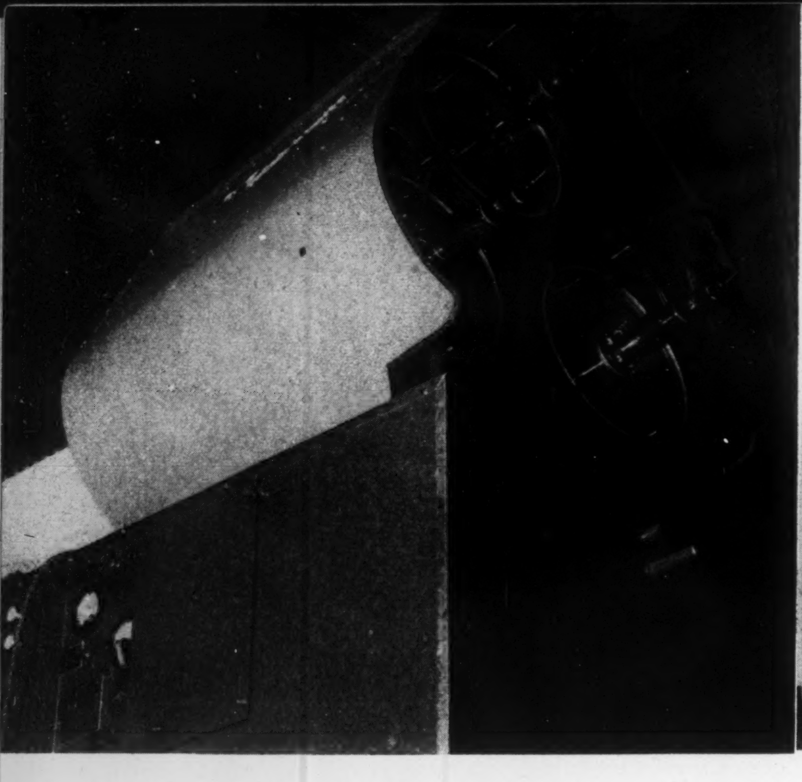
During the war the consumer was led to believe there would be many startling changes and advances made in the designs of postwar machines. It was with some disappointment that he viewed his long awaited new automobiles, refrigerators, and other appliances. For the most part they are the same as prewar models. However, most of the larger manufacturers have new and improved designs ready for production. As more competition develops these will begin to appear. Many are carefully designed for increased utility, easier maintenance, lower costs and maximum sales appeal. In the best of these designs appearance will be an essential consideration, but always carefully related to functional improvements and lower manufacturing costs, *Figs.* 6 and 7.

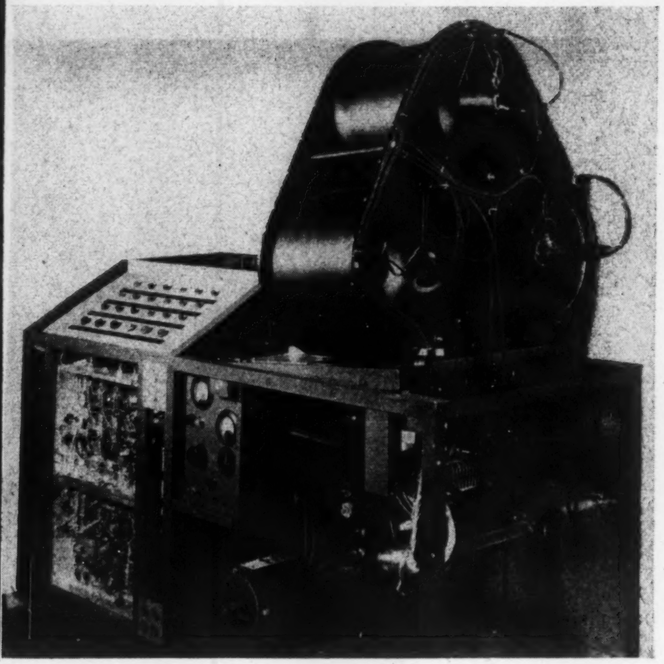
There is little doubt that in the future manufacturers will be calling on the consultant designer more frequently. Some will also organize their own industrial design departments and train their machine designers to visualize preliminary designs in terms of appearance. A general understanding of the factors to be considered in improving the appearance of a design will be invaluable to the preliminary designer of the future. Already we can perceive a trend toward a merger between the industrial designer and the architect, and undoubtedly we shall see a similar relationship developing between the industrial designer and the machine designer.

It would be difficult if not impossible to predict with any degree of certainty specific trends in the appearance of our future designs. A study of the history of art and architecture clearly reveals the repetition of cyclic trends from extreme simplicity and purity of design at the beginning of an art period to the highly decorative, often superficial, treatment of the original basic forms in the last stages of the cycle. It is the generally accepted theory today that we are now emerging from a very confused period of eclecticism or mixed styles of the Victorian era and are in the process of developing a new set of standards for judging design and architecture. We are recognizing the necessity of establishing new forms based on maximum utility and additional safety at lower costs. We are placing emphasis on achieving beauty of design through simplification, careful study of proportional relationships and proper usage of materials, *Figs.* 8 and 9, rather than by superficial application of traditional art forms, additional

(*Concluded on Page* 190)

MANY MORE EXAMPLES of modern machine styling are presented in this month's edition of "Designs of the Month", Pages 156 to 159.



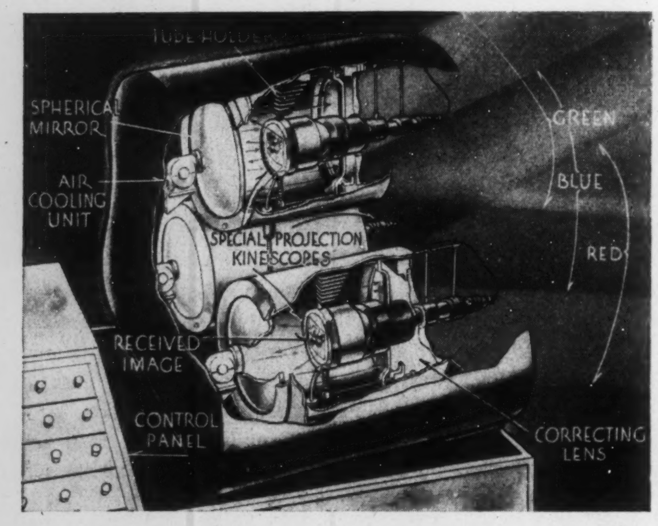


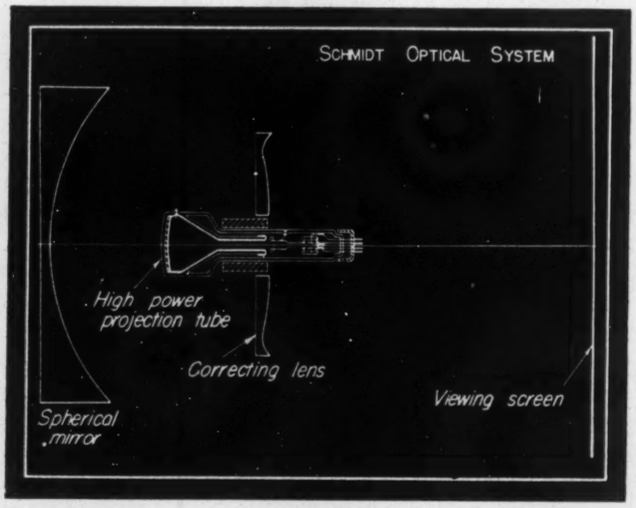
What's Behind Color Television?

ELECTRONIC system of color television developed by the RCA Princeton Laboratories utilizes three separate sets of radio signals for color transmission. Image being televised is passed through a series of filters which successively remove the red, blue and green elements in the beam. The three images are then impressed on separate phototubes and transmitted on separate wave lengths. At the receiver, these three signals are fed individually to three kinescope picture tubes arranged in a triangle. There, the electron beam strikes a coating of phosphor on the tube face and the televised image appears. Since each tube is coated with a phosphor which glows in a color corresponding to that of the signal transmitted to it, a full-color image is produced by optically combining the three images in registration on a screen.

Prior methods of color television have been built around monochromatic systems with added color apparatus. This consisted of color filters which revolved in front of the iconoscope (camera) tube. A similar three-color disk, placed in front of the kinescope and synchronized with the transmitting disk, projected the three fundamental colors on the screen in sequence. Full color images resulted because of the persistence of vision of the human eye. Among the drawbacks were color break-up and illumination loss.

Because the electrical characteristics and standards of the green color image used with the new system are identical with those of the present black-and-white system, any broadcast from color stations using this system can be received on black and white receivers by the addition of a simple radio-frequency converter.


TUBE HOLDER
SPHERICAL MIRROR
AIR COOLING UNIT
SPECIAL PROJECTION KINESCOPES
GREEN
BLUE
RED
RECEIVED IMAGE
CONTROL PANEL
CORRECTING LENS


SCHMIDT OPTICAL SYSTEM
High power projection tube
Correcting lens
Viewing screen
Spherical mirror

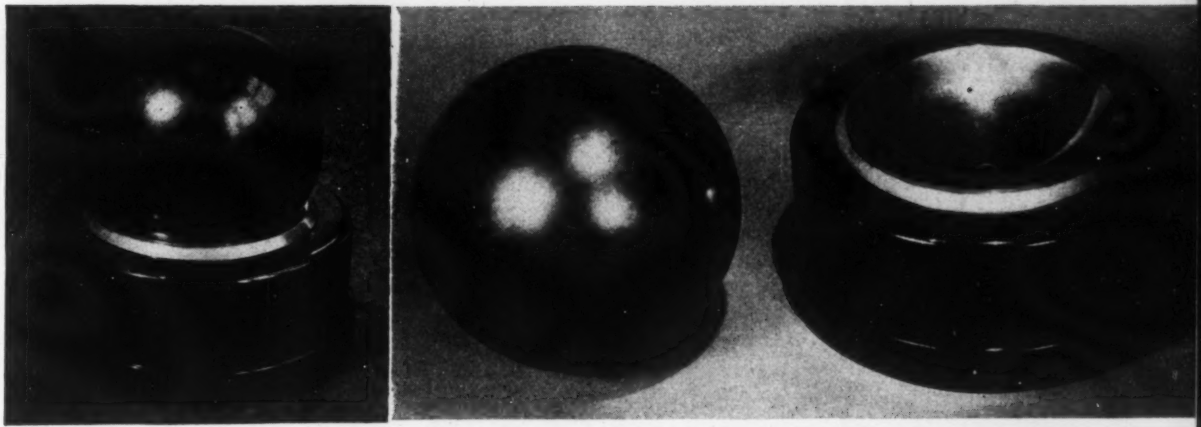


Fig. 25 — Solid steel ball is supported in cup by hydrostatic air pressure at 2 psi. —Photo, courtesy Sperry Gyroscope Co. Inc.

Hydrostatic Lubrication

By Dudley D. Fuller
Columbia University
New York

Part III—Step Bearings

JUST as one picture is worth a thousand words, one vivid demonstration is more impressive than many times a thousand words. The sight of a heavy steel ball spinning freely and smoothly on literally a wisp of air is a most striking demonstration of the low friction that can be produced by using hydrostatic lubrication.

The spinning ball was built by the Sperry Gyroscope Co. to explore the possibilities of using this type of lubrication. It consists of a solid steel ball, weighing about 32 lb, floated in a cup by introducing air at the bottom, the air having a pressure of only 2 psi, *Fig.* 25. Friction between sphere and cup is so low that for all practical purposes the ball is freely supported. Air flow is extremely small, actually less than 0.02-cu ft per min. The ball is so free that, once it is spinning, a slight inequality of air flow up one side will maintain continuous rotation of the ball, hour after hour.

Where hydrostatic lubrication in the form of a step bearing has been applied to vertical turbogenerators in power stations and elsewhere the frictional drag of these bearings has been phenomenally low. After the steam has been shut off and the electrical circuits opened, it is reported, these units spin from 4 to 5 hours before coming to rest.

Again, in applications to machines and mechanisms operating at extremely high speeds the designer has been forced to use this type of load-carrying device where other forms of bearings would result in excessive friction loss, or short life or both. Ultra-centrifuges, for example, running as high as 90,000 rpm have been supported by means of step bearings using air as the lubricant.

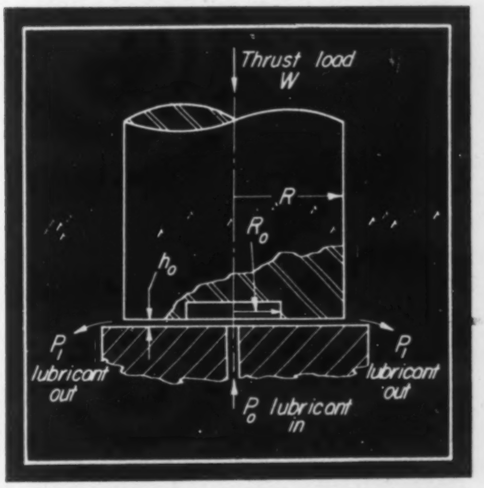


Fig. 26—Schematic diagram of step bearing. Lubricant flows radially outward through annulus, escaping at periphery

Mathematical analysis of these bearings is straightforward and the resultant equations relating the variables of viscosity, pressure, film thickness and oil flow can be conveniently applied to machine design. It is the purpose of this article to derive these fundamental equations and to illustrate their use by reference to typical examples.

In *Fig.* 26 is shown schematically the end of a shaft subjected to a thrust load W. Radius of the shaft is R and there is a recess at the bottom of the shaft having radius R_0. Inlet lubricant pressure is P_0, supplied at center of bearing. Lubricant flows radially outward through annulus of depth h_0 and escapes at periphery of shaft at some pressure P_1, which is usually about atmospheric pressure.

In order to evaluate the load-carrying capacity it is first necessary to determine the rate of change of pressure as the oil flows outward on the step. *Fig.* 27 represents, in the top view, a plan of the bearing with a differential annulus of length $2\pi r$ and depth dr through which the oil is flowing. This is, in effect, a differential slot. The expression for the flow of an incompressible viscous fluid through a finite slot was derived in the first article of this series (M. D., June, 1947, Page 112, Equation 2) and is

$$Q=\frac{\Delta P\, b\, h^3}{12\,\mu\, l}$$

where Q is flow, cu in. per sec, ΔP is pressure difference causing flow, psi, b is width of slot, in., h is thickness of slot, in., l is length of slot, in., μ is viscosity of fluid, reyns (lb-sec per sq in.). Applied to the differential slot this equation becomes

$$Q=-\frac{dp\ 2\pi\ r\ h_o^3}{12\ \mu\ dr}$$

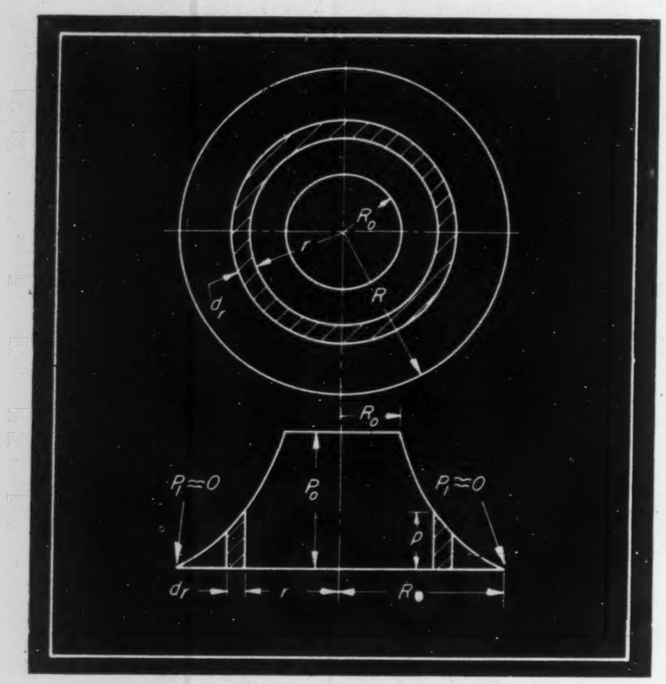
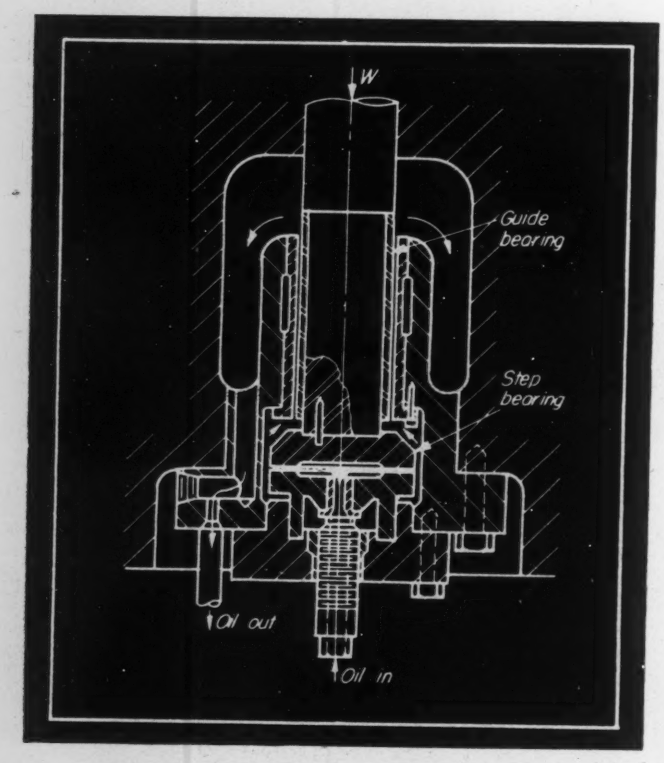


Fig. 27—Above—Plan view (upper) and radial pressure distribution (lower)) of a step bearing

Fig. 28—Below—Application of hydrostatic lubrication to a step bearing for a vertical turbogenerator



The minus sign is used inasmuch as dp/dr is negative. Rewriting,

$$dp=-\frac{6\,\mu\,Q}{\pi\ h_o^3}\,\frac{dr}{r}$$

Integrating

$$p=-\frac{6\,\mu\,Q}{\pi\ h_o^3}\,ln\,r+C$$

where ln denotes the logarithm to the base e.

The constant C is evaluated by considering the boundary conditions that $p = 0$ when $r = R$, from which

$$C=\frac{6\,\mu\,Q}{\pi h_o^3}\,ln\,R$$

so that p, the pressure at any radius r, becomes

$$p=\frac{6\,\mu\,Q}{\pi h_o^3}\,ln\frac{R}{r}\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (19)$$

From this equation the inlet pressure, P_0, required can be evaluated by setting $r = R_0$. Then

$$P_o=\frac{6\,\mu\,Q}{\pi h_o^3}\,ln\frac{R}{R_o}\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (20)$$

It may be noted that the quantity of flow needed to maintain a predetermined film thickness is given by transposing Equation 20 to read

$$Q=\frac{P_o\ \pi\ h_o^3}{6\ \mu\ ln(R/R_o)}\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (21)$$

Now the load-carrying capacity can be evaluated. The lower view in *Fig.* 27 shows a profile of the pressure distribution. The total load-carrying effect will be the sum of the forces exerted by the inlet pressure P_0 acting on the area of the recess of radius R_0 and the variable pressure p acting on the sill area of the bearing. Expressed mathematically,

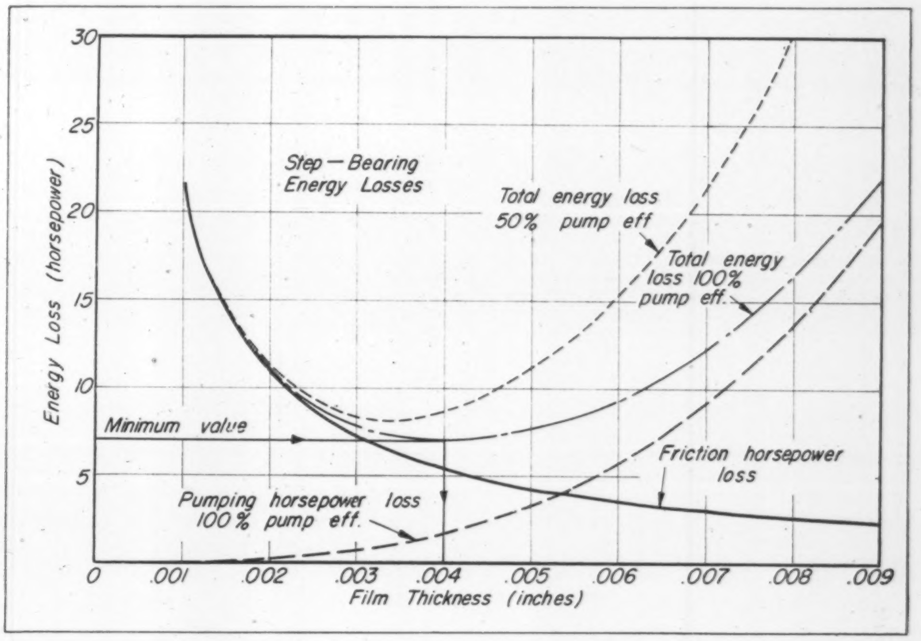
$$W=P_o(\pi R_o^2)+\int_{R_o}^{R} p(2\pi r\,dr)$$

Inserting p from Equation 19,

$$W=P_o\pi\ R_o^2+\frac{12\ \mu\ Q}{h_o^3}\int_{R_o}^{R} ln\frac{R}{r}\,r\,dr$$

Integrating, inserting the limits and substituting for Q from Equation 21

Fig. 29—Right—Curves showing effect of film thickness on energy losses in a step bearing supporting a 101,000-lb load at 750 rpm



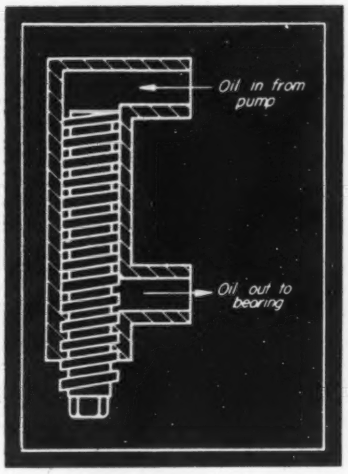


Fig. 30—Left—Adjustable baffler for controlling oil pressure and smoothing out pulsations. Screw adjustment permits flow regulation

$$W=\frac{P_o\pi}{2}\left[\frac{R^2-R_o^2}{ln(R/R_o)}\right] \quad \ldots\ldots (22)$$

This equation is valid even when the recess is eliminated, in which case R_0 becomes the radius of the inlet oil supply pipe and the equation is still determinate.

As an example of the use of this equation in design consider *Fig.* 28. This is a drawing showing the hydrostatic principle applied to the thrust bearing of a vertical turbogenerator of the Curtis type. A typical 5000-kw generator would have a thrust of about 101,000 pounds; outside diameter of step bearing 16 in.; diameter of recess 10 in. Substituting these values in Equation 22

$$101{,}000=\frac{P_o\pi}{2}\left[\frac{(8)^2-(5)^2}{ln(8/5)}\right]$$

from which $P_0 = 774$ psi. In practice about 825 psi is used on this step bearing to provide some margin of safety.

Film thickness in the bearing should be from 0.001-in. to 0.010-in., to protect the surfaces from metal-to-metal contact and allow passage of harmful grit that may find its way into the system. The film thickness determines the oil flow for a given viscosity and pressure.

In the foregoing example, if the film thickness is to be maintained at 0.006-in. with an oil equivalent to SAE 20 at 130F, what will be the quantity pumped in gallons per minute? From the first article of this series, viscosity = 160 saybolt sec, kinematic viscosity = 34 centistokes, mass density = 0.86 approx., and absolute viscosity = 0.86 × 34 = 29.24 centipoises = 29.24 × 1.45 × 10^{-7} reyns = 42.4 × 10^{-7} reyns. Using Equation 21 with $P_0 = 825$ psi and $h_0 = 0.006$-in.

$$Q=\frac{825\times\pi\times(0.006)^3}{6\times42.4\times10^{-7}\times0.470}=46.85 \text{ cu in. per sec.}$$

Converting to gallons per minute, $Q = 46.85 \times 60/231 = 12.17$ gpm.

Total energy losses in such a bearing are made up of (1) the viscous friction on the step due to rotation of the shaft and (2) the energy required to force or pump the lubricant radially outward through the film space. The first part—viscous friction on the step—is proportional to the rotational speed of the shaft. The slower the shaft speed the smaller this effect becomes and at standstill it vanishes. The second part or "pump work" is a constant for any given volume of flow and pressure difference and is independent of shaft speed. This is simply evaluated by expressing the work done in forcing out the oil as

$$E_p= Q(P_o-P_1) \quad \ldots\ldots (23)$$

where Q is flow, cu in. per sec, (P_0-P_1) is pressure difference, psi, and E_p is energy, in.-lb per sec.

Friction loss on the step of the bearing due to rotation can be evaluated as follows, referring to *Fig.* 27. From Newton's equation of viscous friction drag (Equation 1 in the first article)

$$F=\mu A\frac{dv}{dh}$$

Using English units, μ is viscosity, reyns, A is area of surface, sq in., dv is relative velocity, in. per sec, and dh is film thickness, in. For a thin film the velocity gradient is linear so the equation can be written as

$$F=\mu A\frac{\Delta v}{\Delta h}$$

Friction drag on an elemental annulus of radius r and width dr will then be

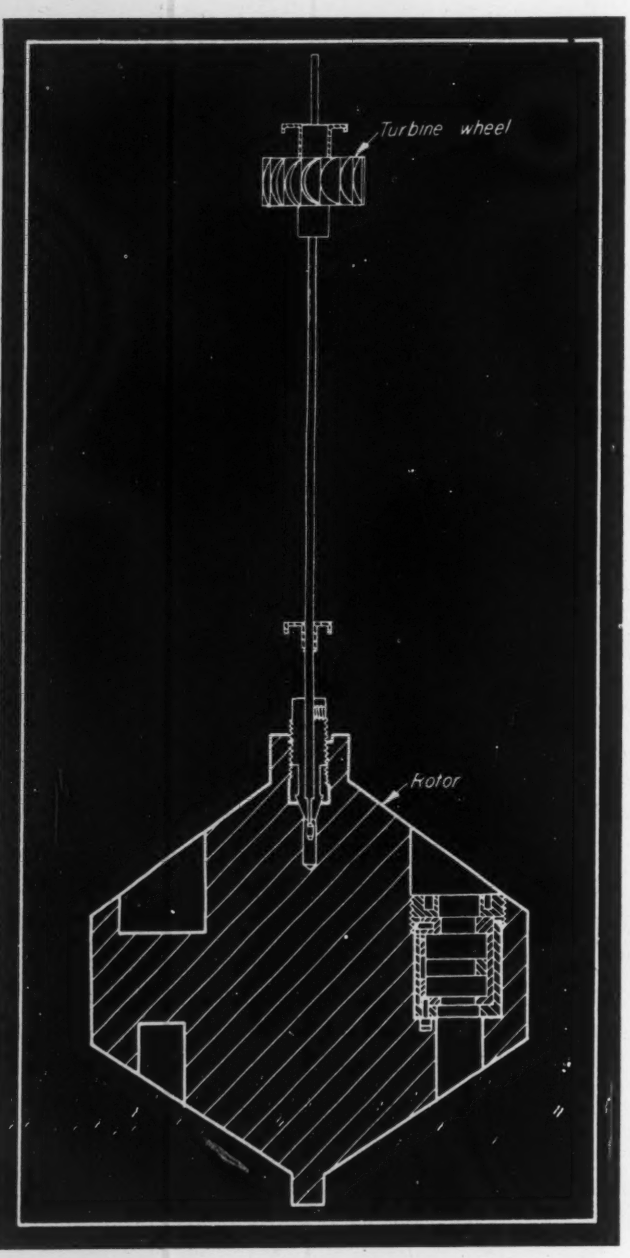


Fig. 31—Air pressure at 5 psi, acting on underside of air turbine wheel, supports this rotor for an 80,000-rpm centrifuge.—Drawing, courtesy The Sharples Corp.

$$dF = \mu\, 2\pi r\, dr \frac{\Delta v}{h_o}$$

With one of the contacting surfaces stationary, $\Delta v = \omega r$, where ω is the angular velocity, radians per sec. Torque on the annulus becomes

$$dT = \frac{2\,\pi\,\mu\,\omega\, r^3\, dr}{h_o}$$

and the total friction torque becomes

$$T = \frac{2\,\pi\,\mu\,\omega}{h_o} \int_{R_o}^{R} r^3\, dr$$

which, on integration, becomes

$$T = \frac{2\,\pi\,\mu\,\omega}{h_o}\left[\frac{R^4}{4} - \frac{R_o^4}{4}\right] \quad \text{..........................(24)}$$

Friction energy is given by the relation

$$E_f = \frac{2\,\pi\,T\,N}{60}$$

in.-lb per sec, where N = rpm. Substituting in this equation $\omega = 2\pi\, N/60$,

$$E_f = \left(\frac{2\,\pi\,N}{60}\right)^2 \frac{2\,\pi\,\mu}{h_o}\left[\frac{R^4}{4} - \frac{R_o^4}{4}\right]$$

which, on evaluating the constants, becomes

$$E_f = \frac{N^2\mu}{58.05 h_o}\left[R^4 - R_o^4\right] \text{in-lb per sec}$$

In the example under consideration the "pumping loss" and frictional loss can easily be evaluated. From Equation 23, $E_p = 46.85 \times 825 = 38{,}680$ in.-lb per sec and the corresponding horsepower $hp_p = 38{,}680/12 \times 550 = 5.86$ hp.

Frictional energy loss, from Equation 25, when running at rated speed of 750 rpm is

$$E_f = \frac{750^2 \times 42.4 \times 10^{-7}}{58.05 \times 0.006}\left(8^4 - 5^4\right)$$

$$= 23{,}770 \text{ in-lb per sec}$$

Corresponding friction horsepower, $hp_f = 23{,}770/12 \times 550 = 3.60$ hp. It will be noticed that the actual frictional loss is extremely low. From Equation 24 the frictional torque is

$$T = \frac{\pi\,\mu\,\omega}{2\,h_o}\left(R^4 - R_o^4\right)$$

$$= \frac{\pi \times 42.4 \times (750/60) \times 2\pi \times 3471 \times 10^{-7}}{2 \times 0.006}$$

$$= 303 \text{ in-lb}$$

With mean radius of collar approximately 6.5 in., tangential friction force = 303/6.5 = 46.5 lb. This corresponds to a coefficient of friction in the bearing equal to 46.5/101,000 = 0.00046.

If the pump loss is charged to the bearing, the total energy dissipated in this example would correspond to an overall "coefficient of friction" of about 0.0012. This is the same order of magnitude as the minimum frictional losses in the standard tapered-shoe type thrust bearing operating on the hydrodynamic principle. For a low pump efficiency, however, the overall energy losses in the hydrostatic step bearing will increase proportionately. A 50 per cent pump efficiency in this example would raise the pumping loss, from Equation 23, to 5.86 × 2, with a total of 11.72 + 3.60 = 15.32 hp and an overall "coefficient of friction" of 0.002.

There is an optimum film thickness that will produce a minimum combination of friction loss and pumping loss. This can be evaluated most easily by determining the minimum point of the curve representing the sum of the respective energy losses when plotted against film thickness.

For the foregoing example, using the same numerical values, the equation for friction horsepower reduces to

$$hp_f = \frac{0.0216}{h_o}$$

By combining Equations 23 and 20 the pumping horsepower becomes

$$hp_p = \frac{(1000\,h_o)^3}{36.85}$$

for a pump with 100 per cent efficiency, and

$$hp_p = \frac{(1000\,h_o)^3}{18.42}$$

for a pump with 50 per cent efficiency. Evaluating the energy losses of this problem with various film thicknesses, the results plotted in *Fig.* 29 are obtained.

It will be noted that the friction losses reduce rapidly as the film thickness is made larger but the pumping losses increase rapidly. For minimum overall energy loss for the system a film thickness of about 0.004-in. is indicated for the high-efficiency pump. If the system were operated with an oil film of 0.006-in. depth, the losses would be somewhat greater but the thicker film would provide a greater margin of safety and actually result in greater oil flow. Greater circulation of lubricant is often desired to act as a coolant and carry the heat out of the bearing.

With the optimum film thickness of 0.004-in. rather than 0.006-in. and the foregoing numerical values from Equation 21, the oil flow would be 13.9 cu in. per sec or 3.61 gpm. Friction energy loss in bearing would be 5.4 hp, pumping loss (for 100 per cent efficiency) 1.74, and total loss 7.14 hp.

With specific heats of oil about 0.5 Btu per lb deg F, weight density, γ, 0.0307 lb per cu in. and the mechanical equivalent of heat $m = 778$ ft-lb per Btu, the temperature rise of the system for 0.004-in. film thickness, assuming all the heat appears in the oil, is obtained as follows, equating the equivalent Btu of the hp loss to the Btu corresponding to the temperature rise of the oil:

$$\frac{hp_t \times 550}{m} = Q \times \Delta T \times \gamma \times S$$

where Q is the flow in cu in. per sec. Solving for the temperature rise,

$$\Delta T = \frac{hp_t \times 550}{m \times Q \times \gamma \times S}$$

$$= \frac{7.14 \times 550}{778 \times 13.9 \times 0.0307 \times 0.5} = 23.6\text{F}$$

For a film thickness of 0.006-in., however,

$$\Delta T = \frac{9.46 \times 550}{778 \times 46.85 \times 0.0307 \times 0.5} = 9.3\text{F}$$

The second condition, of larger flow and smaller temperature rise, is generally more desirable from a practical standpoint.

To provide for control of the oil pressure being supplied to the step and to smooth out any flow or pressure pulsations some kind of restricting adjustable orifice or baffler usually is employed. In one form the baffler consists of a square-threaded screw in a suitable housing, *Fig.* 30. Oil from the pump enters one end of the housing and is caused to flow around a helical path conforming to the threads of the screw. The length of the path is determined by the depth of insertion of the screw and allows for regulation of oil flow and pressure supplied to the bearing. For the example under consideration a pressure drop through the baffler of about 120 psi may be expected, raising the necessary pump pressure capacity to 825 + 120 or 945 psi.

Where several machines are being served by a common oil supply line, the bafflers will allow adjustment to meet the individual requirements of each unit. An accumulator is often employed to smooth the pump pulsations further and act as a reserve in the system.

This hydrostatic principle has been applied to various high-speed centrifuges. One example of particular interest is an ultra-centrifuge built by the Sharples Corp. which operates at a speed of approximately 80,000 rpm. *Fig.* 31 is a cross-section of this centrifuge showing the rotor suspended at the bottom of a slender shaft located be-

Fig. 32—Detail of air-lubricated step bearing on centrifuge. —Drawing, courtesy The Sharples Corp.

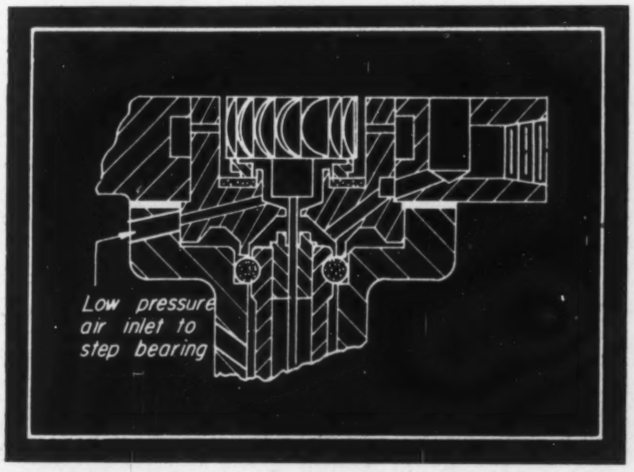
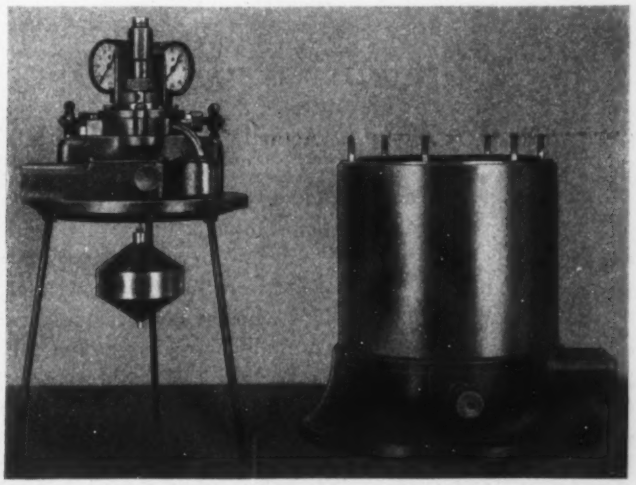


Fig. 33—Rotor and driving head of 80,000-rpm air-lubricated centrifuge, at left, ready for assembly into housing shown at right.—Photo, courtesy The Sharples Corp.



tween guide bearings and supported at the top by a turbine wheel. The assembly is rotated by multiple air jets acting against pockets milled around the periphery of the turbine wheel. Low-pressure air is introduced into the lubricating oil reservoir and serves two functions. One is to maintain pressure on the oil to deliver it to the shaft guide bearings. The other is to allow this low-pressure air to act on the under side of the turbine wheel and, as a step bearing, lift the entire rotating assembly sufficiently to obtain clearance and allow operation with practically no friction. An enlarged view of the turbine wheel is shown in *Fig.* 32, while *Fig.* 33 shows the rotor head and driving head removed from its housing and mounted on a tripod for assembly. On this particular assembly the housing in which the rotor is suspended is evacuated to a point of minimum air friction and the unit operated at a speed of about 80,000 rpm.

Outside diameter of the step is ¾-in.; diameter of recess 11/16-in.; and diameter of shaft 1/16-in. Weight of rotor and shaft is 1.785 lb. Effective force of vacuum acting on shaft cross-sectional area is approximately 0.075 lb. Total effective weight to be carried by the step bearing is then 1.785 + .075 = 1.86 lb. Using Equation 22 and subtracting the shaft cross-sectional area from the load-carrying area of the bearing,

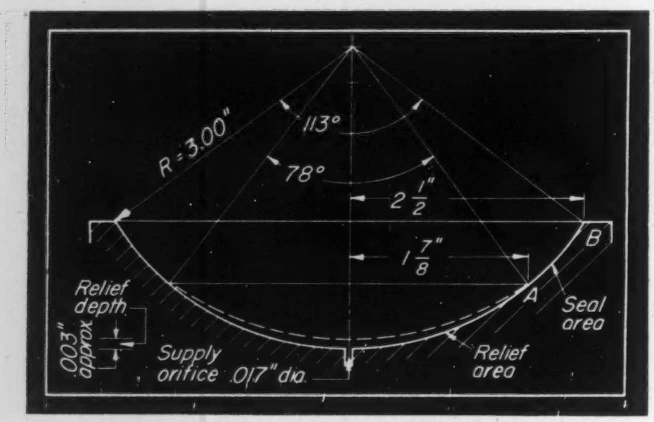


Fig. 34—Detail of supporting cup for air-lubricated ball.—Drawing, courtesy Sperry Gyroscope Co. Inc.

$$W=P_o\frac{\pi}{2}\left[\frac{R^2-R_o^2}{ln(R/R_o)}\right]-P_o\left[\frac{\pi\,d^2}{4}\right]$$

$$1.86=P_o\frac{\pi}{2}\left[\frac{(3/8)^2-(11/32)^2}{ln\,1.091}\right]-P_o\left[\frac{\pi(1/16)^2}{4}\right]$$

From which P_0 = 4.62 psi. Actually 5 psi is used on this step bearing.

Strictly speaking, the application of Equation 22 or any other equations of these articles to a compressible fluid such as air is not exactly rigorous. One of the assumptions upon which the derivations were based was that of an incompressible fluid—a fluid whose volume would not be influenced by pressure. Actually, however, when the pressure drop with air or a similar gas is not too great, as in this example of the ultra-centrifuge, the volume change is small and the equations can be used with good accuracy.

The floating steel ball referred to at the beginning of this article and illustrated in *Fig.* 25 is an interesting illustration of the potentialities of hydrostatic lubrication. *Fig.* 34 shows the details of the supporting cup. The actual arc of the supporting element is 113 degrees with a relieved area in the center extending to within 17½ degrees of the lip. The ball weighs 31.88 lb. Using the projected areas and Equation 22, radius *R* to point *B* is 2½ in., radius R_0 to point *A* is 1⅞-in. Then solving for P_0 from Equation 22

$$P_o=\frac{2\omega}{\pi}\left[\frac{ln(R/R_o)}{R^2-R_o^2}\right]$$

$$=\frac{2\times31.88}{\pi}\left[\frac{ln(2.5/1.875)}{(2.5)^2-(1.875)^2}\right]=2.14\ \text{psi}$$

By actual test, air supplied at a pressure of 4.2 in. Hg or 2.07 psi is sufficient to float the ball freely, indicating excellent agreement between experiment and theory.

When a pressure of 6.2 in. Hg or 3.05 psi was delivered to the base of the cup, the ball rose 0.001-in. and flow was measured at approximately 0.02 cfm. To evaluate the quantity of flow, Equation 21 is used. Equation 21, it must be remembered, was derived for a flat step on the end of a shaft where the film thickness was constant. In this problem the film depth varies. It is a maximum at the edge of the recess, point *A*, and a minimum at the lip of the supporting element, point *B*. Numerically, the film thickness at *A* is 0.001-in. × *cos* 39° or 0.000777-in. At *B* it is 0.001 × *cos* 56.5° or 0.000552-in.

Applying Equation 21 will result in an approximate answer the accuracy of which will depend upon how closely the two film thicknesses approach each other. At 70F the viscosity of air is about 2.6×10^{-9} reyns (lb-sec per sq in.), hence

$$Q=\frac{P_o\,\pi\,h_o^3}{6\,\mu\,ln(R/R_o)}$$

$$=\frac{305\times\pi\times\left[\frac{0.000777+0.000552}{2}\right]^3}{6\times2.6\times10^{-9}\times ln(2.5/1.875)}$$

$$=0.6262\ \text{cu in. per sec}$$

which is equal to 0.6262 × 60/1728 = 0.0217 cfm, an answer which is in remarkable agreement with the actual 0.02-cfm flow measured and which serves to demonstrate further the basic accuracy and ease of application of the various equations of hydrostatic lubrication.

The step-bearing as analyzed and illustrated in this article is one more example of the ease with which hydrostatic films can be designed to carry a wide range of loads with coefficients of friction actually approaching zero. In the next and concluding article of this series the oil cushion will be considered. In conjunction with oil-pad bearings, oil lifts and step bearings, which have already been discussed, the most important applications of hydrostatic lubrication will have been surveyed.

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Centrifugal Impellers

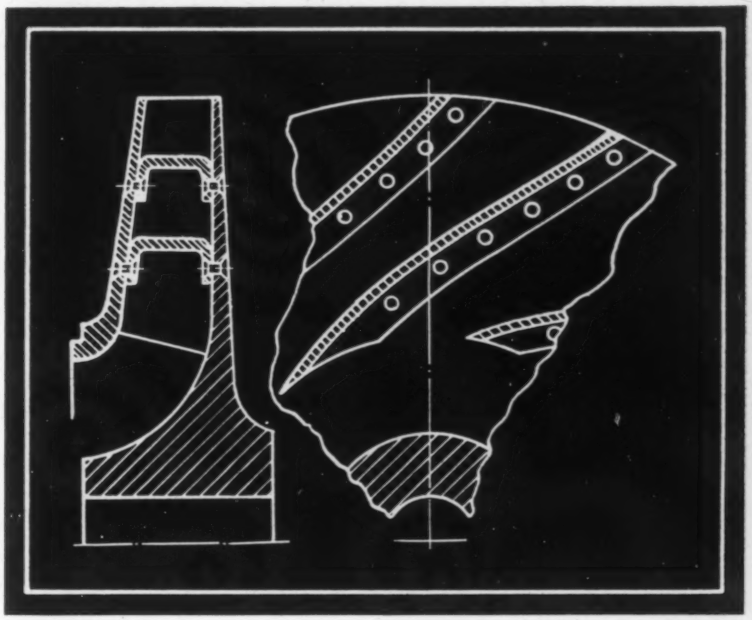
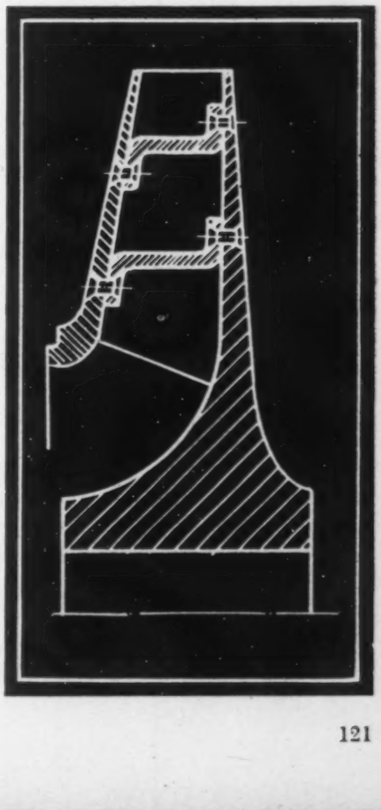


Fig. 1 — Above — Typical fully shrouded centrifugal impeller construction for large-size industrial applications

Practical considerations in their design for applications such as superchargers and gas turbines

By Harold Woodhouse
Enginering Consultant
The Trane Co.
LaCrosse, Wis.

Fig. 2—Below—Alternative method of attaching vanes to shrouds in impellers of the type shown in Fig. 1



As THE tip speed of centrifugal impellers is increased, certain characteristics generally found desirable for good compressor efficiency become progressively more difficult to incorporate in the design. This article discusses the design characteristics which are affected by tip speed with reference to single-flow impellers. For double-flow types the considerations are virtually the same.

A brief review of the different centrifugal impeller constructions used for various tip speeds leading up to the speed range in which aircraft supercharger and gas turbine compressor impellers are operated will illustrate the modifying effect of the tip speed on the designs.

Tip-Speed Range up to 500-700 fps: Large-size centrifugal blower or compressor impellers for standard industrial applications such as supplying air to a blast furnace generally will be of the form shown in *Fig.* 1 with variations in method of vane attachment, one of which is indicated in *Fig.* 2. These are both what is generally referred to as "fully shrouded" impellers, meaning that the air flow passage through the impeller is fully enclosed by the use of side disks which leave only the inlet and discharge tips of the vanes unsupported.

For reasons which will be mentioned later, it becomes more difficult to make impellers fully shrouded as the operating tip speed is increased. However, this particular design characteristic is usually retained whenever feasible, as it makes for higher efficiency because leakage from one vane passage to another across the vane edges is eliminated, thereby cutting down air flow recirculation losses. Furthermore, fully shrouded impellers do not have to rely on close axial running clearances to minimize leakage as they are provided with replaceable tightening,

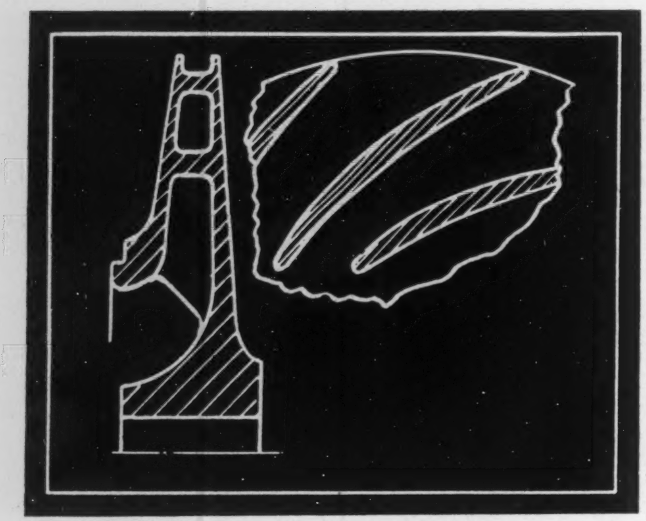
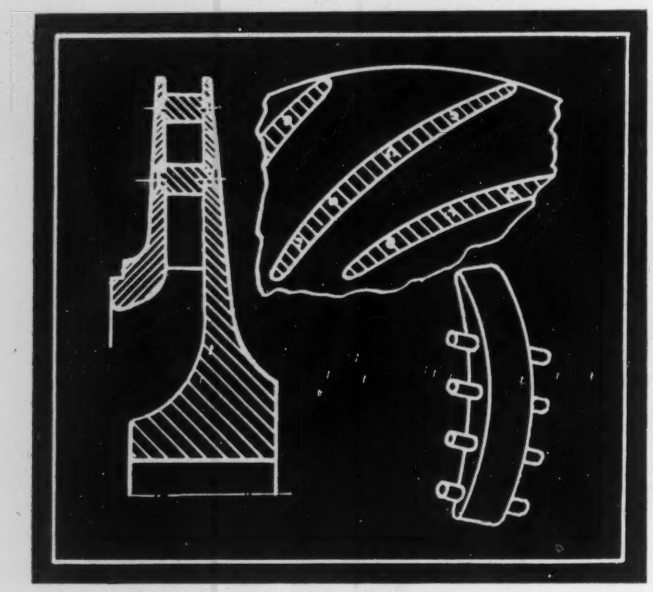


Fig. 3—Above—Cast impeller suitable for tip speeds up to 1000 fps, usually heat-treated aluminum alloy

Fig. 4—Below—Fabricated impeller for service similar to that of the one shown in Fig. 3. This type of construction permits machining the vanes smooth



or wearing, rings. As the vanes are supported on both edges, failure of the vanes due to vibration is not as frequent as with the unshrouded types.

The vanes are pressed to shape and, after machining, are riveted to the side disks. Bending stresses caused by centrifugal pull on the portions of the vanes running parallel to the axis of rotation, and the strength of the side disks, put a definite limitation to the speed at which this type may be run, so they are not used above the 500 to 700 ft per sec tip speed range.

Tip-Speed Range 700 to 1000 fps: For somewhat higher speeds, that is, to approximately 1,000 ft per sec tip speed, the design generally would be as indicated in *Fig.* 3 or *Fig.* 4. Basically these two designs are identical, the only difference being that *Fig.* 3 shows a cast impeller and *Fig.* 4 one that is fabricated. The choice of using one or the other design would depend chiefly on the answers to two questions: (1) How many have to be made and (2) how necessary is it to strive for the very peak of attainable efficiency? If a large number have to be made or at least a moderate regular production is assured and it is not essential that the last iota of efficiency be obtained, then the expense incurred in making patterns to produce a cast impeller as shown in *Fig.* 3 would be justified. If only a few impellers are required or it is necessary to aim for maximum possible efficiency, then the fabricated design of *Fig.* 4 would be more appealing as the cost would be limited to that of materials, machining and riveting. The smooth machined surfaces should give better performance than the relatively rougher ones of the cast impeller.

For cast impellers a high-tensile, heat-treated aluminum alloy like 24ST is generally employed, as its strength-weight ratio compares favorably with that of steel and it makes a cleaner casting. The casting is also much easier to trim, particularly in the partially inaccessible vane passages. This type is commonly used in superchargers for large diesel engines.

When fabricated the vanes are machined from forged

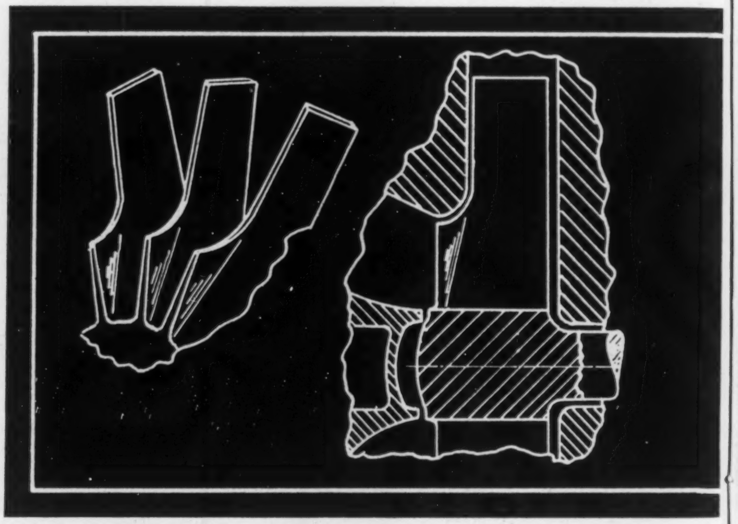
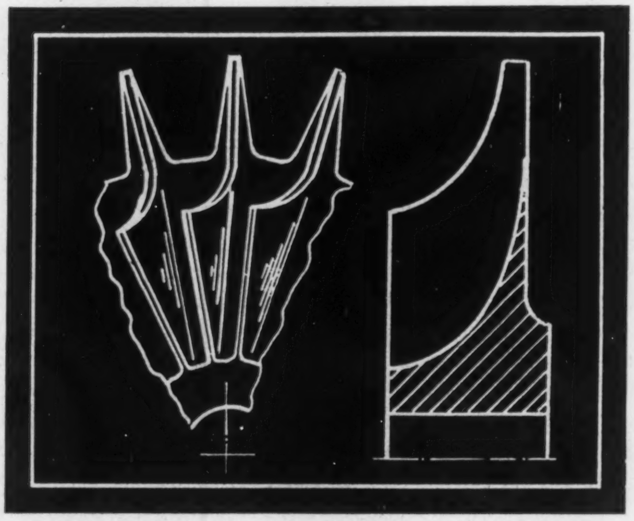


Fig. 5—Above—Impeller forged integral with shaft is suitable for tip speeds up to 1200 ft per sec

Fig. 6—Below—Cast variation of impeller shown in Fig. 5 has improved performance due to more favorable shape



aluminum bars and are riveted to side disks which are also of forged aluminum. If the forging material used is heat-treated 14ST aluminum alloy, it will have at room temperature an average ultimate tensile strength of 69,000 psi, which is higher than many grades of cold-rolled steel and much better on a strength-weight ratio basis. One characteristic of aluminum, either cast or forged, which is of importance to the designer is that its strength decreases rapidly with increase of temperature. At 300 F a temperature commonly found at the discharge of a high-speed impeller, the ultimate strength of 14ST has dropped to 43,000 psi and at 400 F it is only 17,000 psi.

Design Limitations of Cast and Fabricated Types

Fundamentally these two designs are similar to the slower speed type previously mentioned and, to a lesser degree, suffer from similar design limitations. In the cast impeller the vane attachment is not a source of weakness, but the strength of the alloy is less than that used in the forged, fabricated type. The vanes, being cast, are heavier than required for flow guidance alone, causing a larger than necessary centrifugal load on the side disks. The bending stress in the vanes is low since the vanes are thick compared with the passage width. In the fabricated type the vanes are made heavy enough to provide metal thickness for through rivet holes or to allow rivets to be made an integral part of the vane as shown in *Fig.* 4. For either the cast or fabricated design, the strength of the side disks is a limiting factor, as they must carry the entire centrifugal load of the vanes.

Tip Speed Range 1000-1200 fps: For even higher speeds all elements of the vanes must lie in radial planes to eliminate bending stresses, and the vanes must be machined integrally with the hub so that there will be no additional dead load represented by vane fastenings to be carried by the hub. Usually, in this next speed range—1000 to 1200 ft per sec tip speed—it is necessary to discard the separate side disks, *Figs.* 5 and 6, since the tangential and radial stresses caused by the centrifugal forces acting on the disks, even without any superimposed vane load, would cause them to burst. These two designs are typical of those used for the highest speeds ordinarily found in industrial applications.

Impeller and shaft in *Fig.* 5 are one forging. The vanes are milled as flat radial plates after which the inlet edges are bent slightly to adjust them somewhat to the relative flow angle. Since the inlet vane angle after bending may still be larger than desirable, stationary vanes are sometimes installed just ahead of the impeller to impart a whirling motion to the inlet flow and increase still further the relative flow angle. This has the effect, however, of lowering the head produced.

Efficiency of this type is low because of: (a) High leakage from one vane passage to another; (b) turbulence losses due to the rapid change in direction of the flow from axial inlet to radial discharge; (c) shock loss due to improper relative inlet vane angle along most of the vane

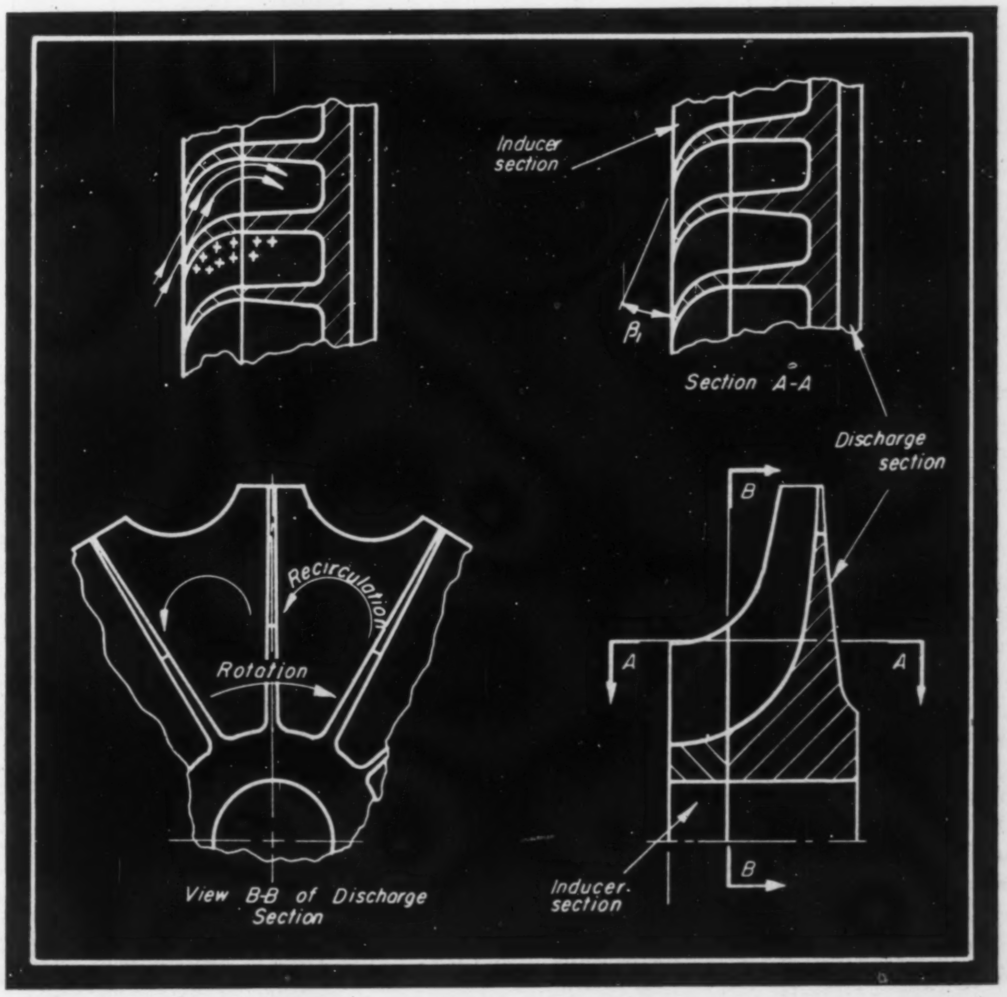


Fig. 7—Type of impeller commonly used for the highest speeds. Although easy to produce, this impeller is not highly efficient

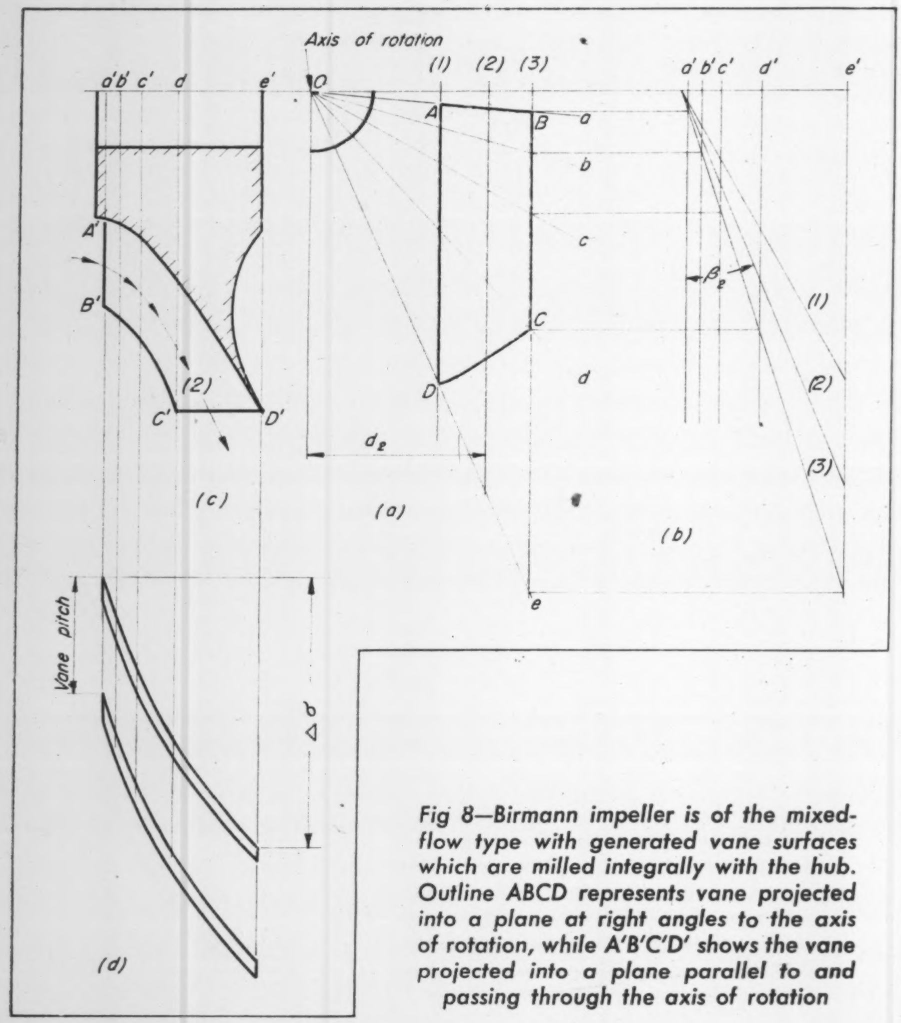


Fig 8—Birmann impeller is of the mixed-flow type with generated vane surfaces which are milled integrally with the hub. Outline ABCD represents vane projected into a plane at right angles to the axis of rotation, while A'B'C'D' shows the vane projected into a plane parallel to and passing through the axis of rotation

inlet edge; (d) friction loss of stationary inlet guide vanes; (e) turbulence and recirculation losses due to poor guidance offered by the small number of flat, radial impeller vanes (usually twelve). The small length of vane root attachment to the hub limits the speed of this type.

A cast variation of this type, *Fig.* 6, has the advantages of giving better flow guidance along the roots of the vanes, less leakage between vanes because of the partial shrouding effect of the extended hub, and greater length of attachment of the vanes to the hub.

TIP SPEED RANGE 1200-1900 FPS: The extreme limit of speed for which centrifugal compressors of appreciable size are now in use—1200 to 1900 ft per sec tip speed—is most likely to be found in applications for aircraft internal combustion engine gear-driven superchargers, turbo-superchargers, gas turbines, or aircraft jet engines.

While, for the lower speed types, good compressor efficiency may be described as desirable and in a supercharger application it is highly important, for a gas turbine it is vital since, without a certain minimum efficiency, the unit will not even turn over without a supply of energy from an external source. This necessity for high efficiency in gas turbines accounted for the general trend toward the axial-flow compressor, which can handle large flows with high efficiency. More recently there has been some reaction from the use of the axial-flow back to the centrifugal compressor for the following reasons connected with axial flow compressor design: (a) Superior efficiency is not entirely realized if there is a failure to recover completely the energy contained in the leaving velocity; (b) efficiency is sensitive to dirt on the airfoil vanes; (c) range of operation for peak efficiency is extremely limited; and (d) cost for a commercial application can be prohibitive.

Inducer and Discharge Sections

By far the most-used type of impeller in this speed range has been that illustrated in *Fig.* 7. It consists of an inlet section called an "inducer" having radial vanes integral with its hub and curved to give the desired relative inlet angle β_1. At the opposite face of the inducer its vanes match the flat, radial vanes of the discharge section. Both sections are generally of high-strength, forged aluminum alloy, although some steel inducers have been used recently. The discharge section hub is extended in the form of a radial web to perform the same function as a side disk in the low-speed types—to prevent flow leakage from one vane passage to another at the back of the impeller. It also ties the radial vanes together, thereby helping to dampen out vane vibrations.

Efficiency of this type, particularly as it is operated toward the upper limit of its speed range, is not very high, for the following reasons:

a. Radius of curvature of the vanes in the inducer is too small. Originally the vanes were milled flat and bent to shape in a die. Later the vanes were machined to shape to improve the contour, and further developments included the widening of the inducer section to make possible the use of a larger radius of curvature. In any case the radius of curvature is relatively small, resulting in a rapid change of direction of the flow and causing localized regions of high specific vane loading—indicated by + signs in the view at upper left of *Fig.* 7—which leads to flow separation, turbulence and recirculation. Or, to use aerodynamic terms, if an individual inducer vane is considered as an airfoil, it may be said that its lift coefficient is too high, causing stalling of the flow.
b. Because of the turbulent conditions existing in the inducer, the inlet vane angle must be considerably increased over that theoretically required in order to pass the designed flow; this probably causes some shock losses at the inlet vane edge.
c. The sudden change in direction of the flow from an axial inlet to a radial flow discharge adds to the turbulence.
d. Guidance provided by the radially diverging vanes is progressively poorer as the discharge is approached,

Fig. 9 — Right — Setup for generating the vanes on the Birmann impeller, the blank being mounted in a freely swinging cradle

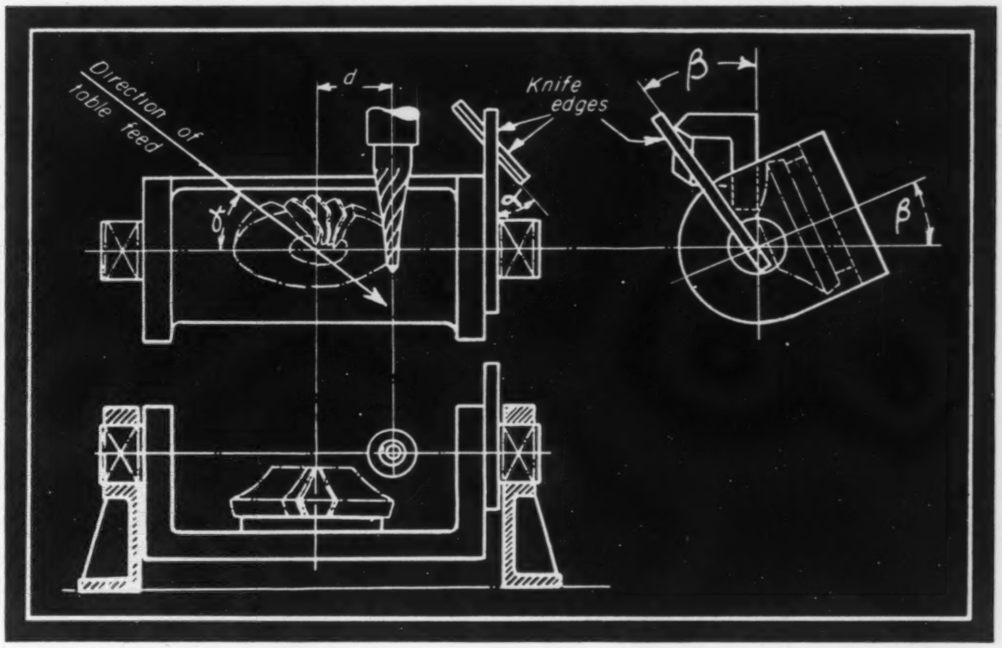
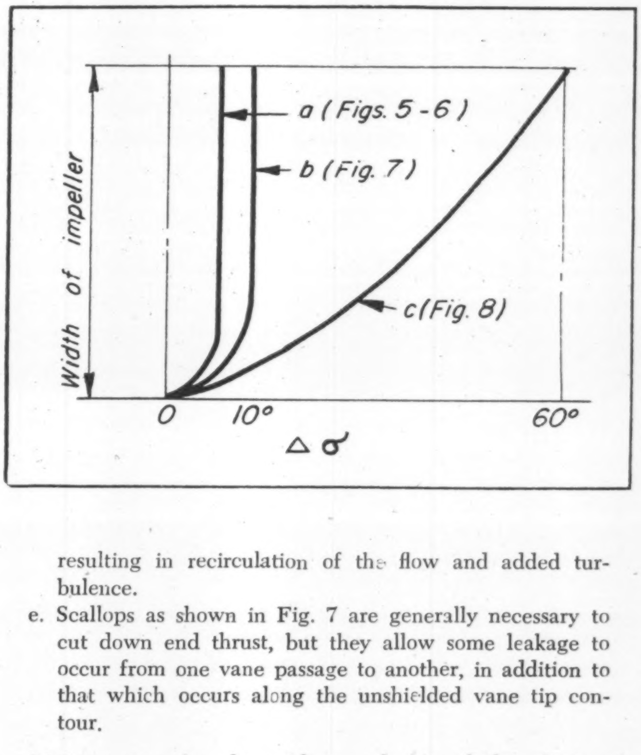


Fig. 10—Below—Developed views of the vanes in three types of high-speed impeller. Abscissa represents angle of wrap of the vane around the circumference



resulting in recirculation of the flow and added turbulence.

e. Scallops as shown in Fig. 7 are generally necessary to cut down end thrust, but they allow some leakage to occur from one vane passage to another, in addition to that which occurs along the unshielded vane tip contour.

Main reason for the widespread use of this design is that of all the high-speed types it is the easiest to machine and to put on a production basis. A more efficient design, known as the Birmann impeller, *Fig.* 8, but more difficult to make, is of the mixed-flow type, with generated vane surfaces which are milled integrally with the hub. The vane surface may be briefly described as a doubly ruled surface, consisting of one series of radial lines *Oa*, *Ob*, etc., *Fig.* 8*a*, and, set obliquely to these, another series of straight lines (1), (2), etc., whose elements all lie in parallel planes. The flow takes place substantially along the latter set of lines, as illustrated by the projection of line (2) into the cross-section of the impeller, *Fig.* 8*c*. The outline of the complete vane when projected into a plane at right angles to the axis of rotation is given by *ABCD*, *Fig.* 8*a*, and when projected into a plane parallel to and passing through the axis of rotation it is given by *A′B′C′D′*, *Fig.* 8*c*.

From the illustrations it may be seen that any point on radial line *Oa* will lie in plane *a′*, *Figs.* 8*b* or *c*, and any point on radial line *Oe* will lie in plane *e′*. If planes *a′* and *e′* correspond respectively to the inlet and back faces of the impeller vanes, the position of any intermediate planes *b′*, *c′*, etc., corresponding to radial lines *Ob*, *Oc*, etc., can be determined. The angle β which any of the lines (1), (2), etc., makes with parallel planes *a′*, *b′*, etc., is determined as follows: The angle β_2, for instance, which line (2) makes with planes *a′*, *b′*, etc., is defined by the expression $K = d_2 \tan \beta_2$ where d_2 is the length of the normal from line (2) to the axis *O*, and *K* is a constant which depends on design conditions and therefore may be used to find angle β for any value of *d* since

$$K = d \tan \beta = d_1 \tan \beta_1 = d_2 \tan \beta_2 \ \ldots\ldots = d_n \tan \beta_n$$

Diagrammatically, the arrangement for generating the vanes is illustrated in *Fig.* 9. The impeller blank to be machined is mounted in a freely swinging cradle. Its position and rate of swing are determined by two knife edges set at an angle α to each other. One knife edge is attached to the cradle and set radially from the centerline of the cradle bearings, the other is set independent of both the motion of the cradle and of the table on which the cradle rests.

Control of Vane Thickness

The direction of feed of the table on which the cradle is mounted is at an angle γ to the vertical plane through the cradle bearings. The only function of angle γ is to obtain an additional measure of control over the vane thickness at different points. The cradle is so mounted that the centerlines of the milling cutter and of the cradle bearings are always in the same horizontal plane. Then, if angle α has been correctly chosen and the relationship $K = d \tan \beta$ is obtained for any one position, it will automatically be obtained for any other. It should be noted in *Fig.* 8 that, for layout convenience, the impeller is kept stationary and the cutter centerline, as given by lines (1), (2), (3), etc., is moved into different positions, which is the opposite of what actually occurs when a vane is being cut.

Features tending to give this mixed-flow type a higher efficiency than the impeller of *Fig.* 7 are:

a. Since the flow takes place along substantially straight lines (1), (2), (3), etc., *Fig. 8a,* while being acted upon by centrifugal force, deflection of the flow, which always causes a loss, is held to a minimum.

b. Although all elements of the vanes lie in radial planes, the relative direction of the discharge flow is not radial but somewhat backward, and generally this results in a higher efficiency than if the relative direction of the discharge flow is radial or inclined forward in the direction of rotation. This is because the effect is to reduce the absolute leaving velocity and the losses associated with high velocities are consequently also reduced. This is particularly important for very high-speed, high-flow impellers because it makes it possible for the impeller tip speed to exceed that of sound, or in other words, a Mach number of unity, while the absolute leaving velocity of the flow remains at a lower value and thereby compressibility and turbulence effects in the discharge are avoided or reduced.

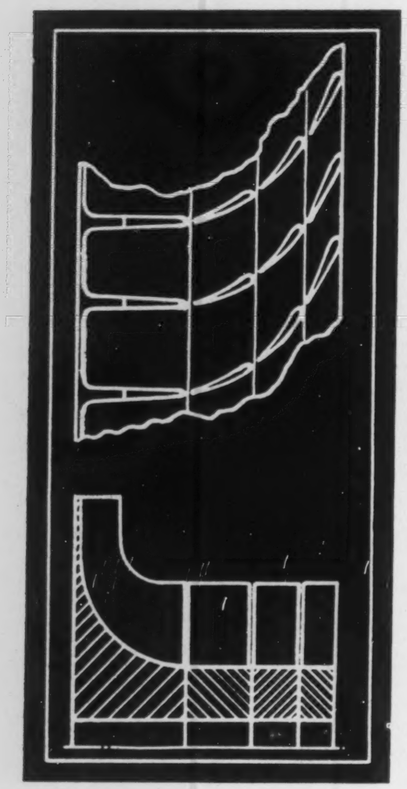


Fig. 11 — Planiol-Szydlowski supercharger impeller is highly efficient but expensive to make

c. From the developed view of a vane as shown in *Fig. 8d* it will be seen that the vane wraps itself around the circumference of the impeller by an amount given as $\Delta\sigma$. Furthermore, there is no sudden change of direction imposed on the flow as the radius of curvature is quite large. It might be said that the aerodynamic constraint imposed on the flow is relatively uniform, a condition which could be shown mathematically to be roughly that necessary for maximum efficiency.

Since for equal impeller speeds $\Delta\sigma$ may be taken as a measure of the time in which the flow is forced to take up the full rotational velocity of the impeller, then the larger $\Delta\sigma$ is and the smoother the curve the less likelihood there is of turbulence being set up due to too rapid a change in direction of the flow. The superiority of the Birmann impeller in these respects is clearly shown if $\Delta\sigma$ is plotted as abscissa with width of impeller as ordinate, *Fig.* 10, for several of the high-speed types discussed.

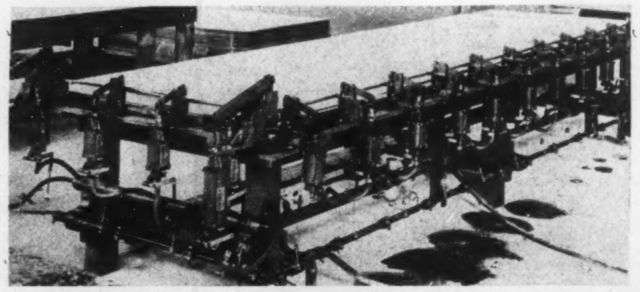
Curve (*a*) for the impellers of *Figs.* 5 and 6 will not ordinarily have a $\Delta\sigma$ in excess of 5 degrees; curve (*b*) for the impeller of *Fig.* 7 shows a $\Delta\sigma$ maximum of 15 degrees, all of which is concentrated in the inducer; curve (*c*) for the Birmann impeller shows a $\Delta\sigma$ in excess of 60 degrees and it is spread over the whole width of the impeller. Evidence that this design creates much less turbulence in the inlet is that it is necessary to increase the inlet vane angle only slightly over the theoretical value to pass the designed flow, whereas a considerable increase is necessary for the design of *Fig.* 7.

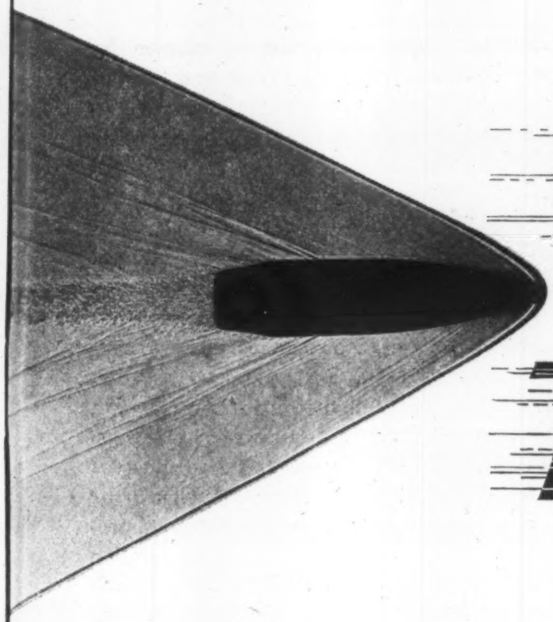
d. As the vanes are wrapped around the hub by an amount $\Delta\sigma$ the rate of divergence of the vanes is less than with the radial discharge type as the vane passage is longer and less turbulence and recirculation will occur.

There is another high-speed type which is of interest, although it has not had widespread application in this country, having been originally designed and developed in France where, incidentally, the first aircraft turbo-supercharger, later made in this country by the General Electric Company, was developed by Professor Rateau. The type referred to is the Planiol-Szydlowski supercharger impeller shown in *Fig.* 11. It is ingenious and highly efficient but expensive to make, and consists of several airfoil vane fan wheels ahead of a radial vane discharge section similar to that of *Fig.* 7. The angular setting of the vanes is progressively increased from the inlet toward the discharge section. This has the effect of making the flow path through the fan wheels approximate that of the Birmann impeller. A novel feature is the gap between successive airfoils, giving a slotted wing effect which breaks up the boundary layer and helps to preserve laminar flow.

Air Motors Sub for Punch Press

HOW a set of air motors does the work of a punch press is shown in the photograph below. The unit notches two corners and punches fifteen holes simultaneously in a 4 by 12-ft sheet of 18-gage steel at the rate of 90 sheets per hour. Each punch is operated by a 2½-inch stroke Bellows air motor, the notchers employing 6-inch stroke motors. A single foot pedal controls all motors.





High-Speed Photography

. . . techniques make it possible for designers to study and develop mechanisms for operating speeds too high for the eye to perceive

By G. A. Hawkins
Westinghouse Research Professor of Heat Transfer

and

C. E. Balleisen
Associate Professor of Mechanical Engineering

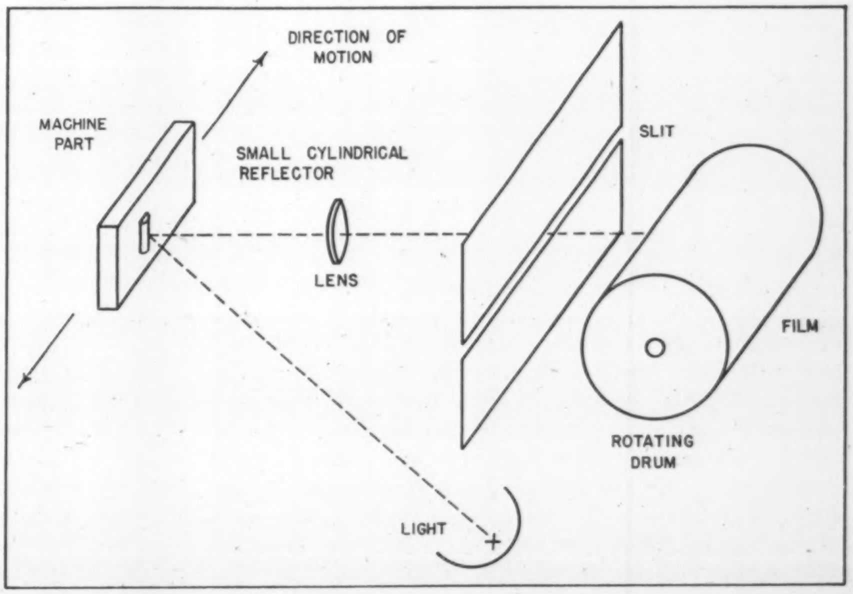
Purdue University

Part I–External Surfaces and Opaque Objects

DURING the war years various members of the U. S. Army Ordnance Experiment Station of Purdue University were engaged in research work dealing with the study and analysis of the mechanisms employed in high cyclic rate machine guns. It is felt that use of many of the same techniques and apparatus for the analysis of machines other than machine guns deserves attention and also that a brief discussion of this equipment and its field of application may prove to be of benefit to design-

Fig. 1—Top Left—Limitations of the human eye in observing motion phenomena at any but moderate or low speeds have resulted in development of many high-speed photographic recording methods, of which this shadow photograph of a bullet in flight is representative

Fig. 2—Below—Sketch showing the schematic layout of a displacement type camera for photographing straight-line machine motions



ers of all types of machines whose parts operate at high speeds.

Limitations of the human eye to follow motion make it necessary for the design engineer to utilize instruments to record data which may later be observed and analyzed, *Fig.* 1. Engineers and scientists have been actively engaged in the study of instruments to supplement the human eye so that motions of a machine element operating at speeds too high for the eye to follow may be recorded. Many devices have been successfully developed and, if properly used, become valuable tools for designers of machines. Some of the equipment which will be discussed includes single-flash cameras, high-speed motion picture cameras, high-speed x-ray units, and time-displacement cameras. Although there are many different types available, only those familiar to the authors will be considered in this discussion. Each specific type of instrument will be considered separately together with some of the special techniques relating to it. The order of presentation will be as follows: Displacement camera, high-speed single photographs by reflected light, high-speed single-exposure shadow photographs, Schlieren photographs, high-speed radiography, motion picture photography, and other methods using photographic recording of data.

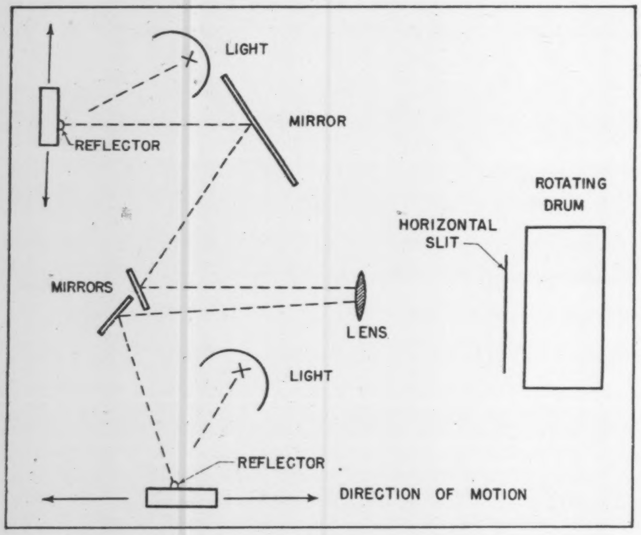
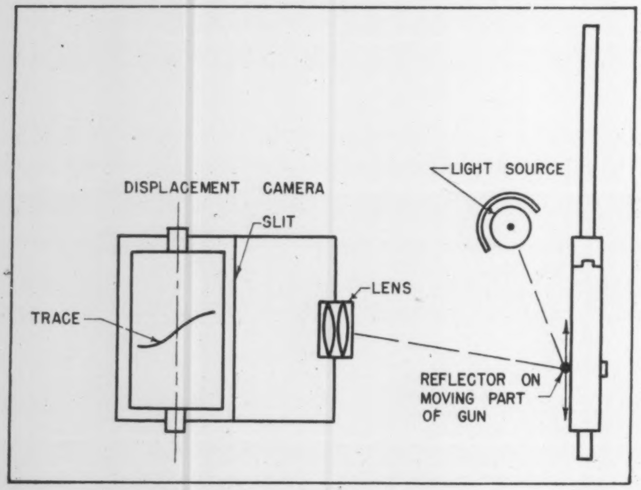


Fig. 3—Above—Schematic layout of displacement camera for recording motion of two independent machine elements

Fig. 4—Below—Arrangement of equipment for obtaining a bolt displacement diagram for an automatic gun



Displacement Camera: In the operating analysis of machine parts it is often desirable to know the accelerations and velocities at various positions during the travel of an element along a straight line. This can easily be accomplished at low cost by means of a displacement camera. In its most simple form, the displacement camera consists of a light source, reflector, lens, slit, and rotating drum as shown in *Fig.* 2. A small cylindrical reflector, made from a half section of a round bar which has been silver plated and polished, is attached to the machine part at any convenient location. Any common method can be used to attach the reflector to the machine element, providing it is sufficiently secure to withstand acceleration forces. Light reflected from the polished surface is collected by the lens and the image made to fall on a drum, around which is wrapped a piece of sensitized photographic paper or film. The speed of the drum can be varied by using a variable transmission or a belt drive.

This type of camera does not record a pictorial image, but instead, a tiny spot of light. The lens system of the apparatus is such that the image is reduced as much as possible in the direction in which it is moving. Only a very narrow strip of paper is exposed at any one instant, and the combined motion of the spot of light and the paper results in obtaining, photographically, a time-displacement plot of the moving part. A record of this type does not contain an inherent time scale. It is necessary to provide one by recording on the paper the passage of time in small increments. For example, an auxiliary spark device may be attached to the unit so that tiny holes are burned by the spark on the paper at predetermined time intervals. In general this type of equipment is limited to use in analyzing elements which move in straight lines.

Relative Movements of Several Parts Can be Recorded

Motion of two machine elements operating in different directions may be recorded on the same film by use of reflecting mirrors as shown in *Fig.* 3. Due to the construction of the focal plane slit, it is necessary that all of the reflections fall on the same longitudinal element of the drum. Loading and unloading of the camera may be carried out in total darkness, or the drum and housing may be so designed that they can both be carried as a unit into the darkroom for loading and unloading.

Illumination of the object is of prime importance in recording fast-moving phenomena. If the moving spot of light on the paper is 1/16-inch in diameter, and it moves at 40 feet per second, it will pass over a given point in 1/7680-seconds. This is a very short exposure and requires extremely brilliant illumination. In opposition to this requirement is the fact that, in order to obtain sufficient illumination for this work, a large-filament lamp is required because multiple light sources cannot be used. Use of a large light source prohibits the formation of a finely focussed spot and conceals delicate details of the photographic record.

When recording a motion, it is disconcerting and difficult to read if the record does not start at one edge and

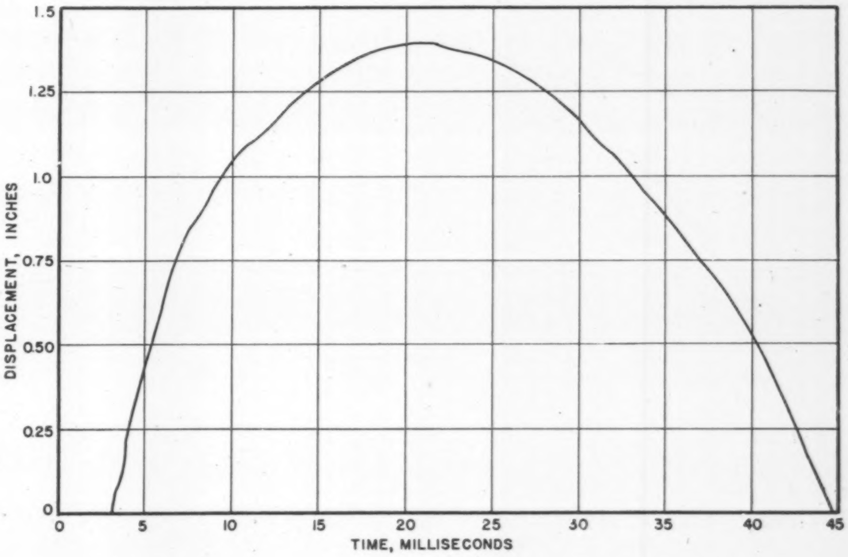


Fig. 5—Right—Typical time-displacement diagram for the barrel of an automatic machine gun

run continuously across the sheet. Further, difficulties in interpretation may be encountered if more than one cycle appears recorded on the same sheet of paper. These difficulties may be avoided successfully by careful control over the opening and closing of the shutter. It is best to provide a series of adjustable time-delay circuits and integrate them with an initiating switch attached to the mechanism under examination. By this means, the camera shutter will open at the desired instant after the switching motion is initiated, and will remain open only for the length of one cycle or as much of the cycle as is desired and preselected.

One of the numerous applications of this apparatus has been in obtaining displacement records for the various parts of high-speed automatic weapons, such as a machine gun. A typical set up of the apparatus for obtaining a bolt displacement diagram for a gun would be as shown in *Fig.* 4. The record which would be obtained on the photographic film or plate for the time-displacement of the barrel of a gun is shown in *Fig.* 5. From this diagram the velocity and acceleration may be computed and suitable diagrams drawn, corresponding velocity and acceleration diagrams for the time-displacement curve of *Fig.* 5 are shown in *Figs.* 6 and 7. Retardations due to friction are easily detected by careful study of the various displacement diagrams. By means of the acceleration values for the elements, inertia forces and stresses may be found.

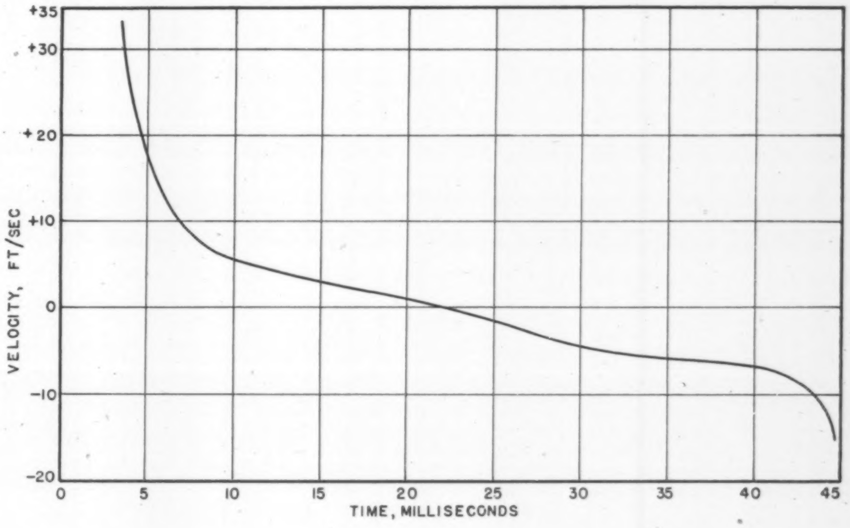


Fig. 6—Right—Time-velocity diagram corresponding to time-displacement diagram for gun shown in Fig. 5

Another important application is

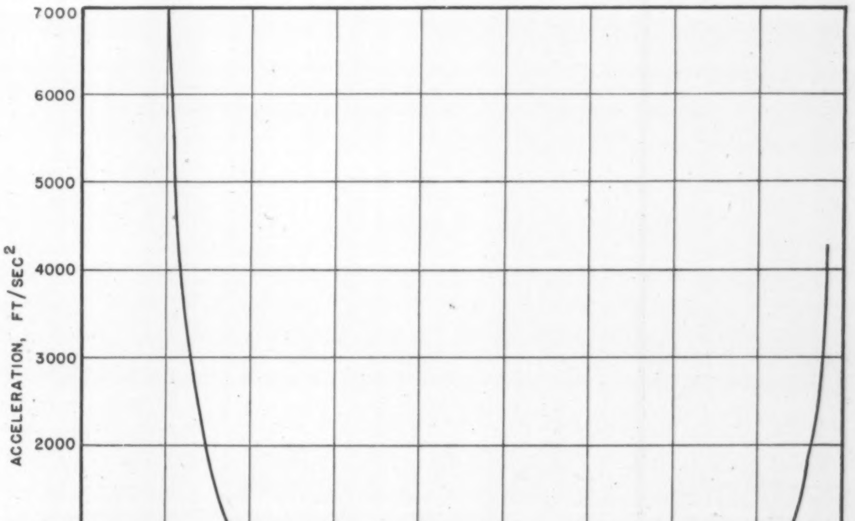


Fig. 7—Right—Time-acceleration diagram corresponding to time-displacement diagram for gun shown in Fig. 5

use in analyzing the motion of springs. The deflection of each coil of a spring against time is easily determined by use of the displacement camera. Usually a small surface area on each coil of the spring is polished to serve as a reflector. The traces for various coils may be recorded on one diagram as shown in *Figs.* 8 and 9. The advantage of this type of record is that the motion of any coil as well as of the entire spring may easily be studied. Transient wave reflections which often cause objectionable spring performance are clearly shown in displacement diagrams of this type.

For computing stresses in tubes due to temperature gradients it is necessary to know something about the temperature change with time through the wall of the tube. Special apparatus has been developed at Purdue University and by other organizations for measuring rapid temperature changes employing thermocouples and cathode ray oscillographs. The actual temperature-time records are recorded on photographic paper by means of the displacement type camera. A typical temperature change record is shown in *Fig.* 10. The timing lines shown in the upper part of the diagram are photographed by impressing a specified cyclic voltage variation on the screen. Following the time record the actual changes are recorded and, by regulating the speed of the drum, temperature changes occurring in time intervals as small as milliseconds may be recorded.

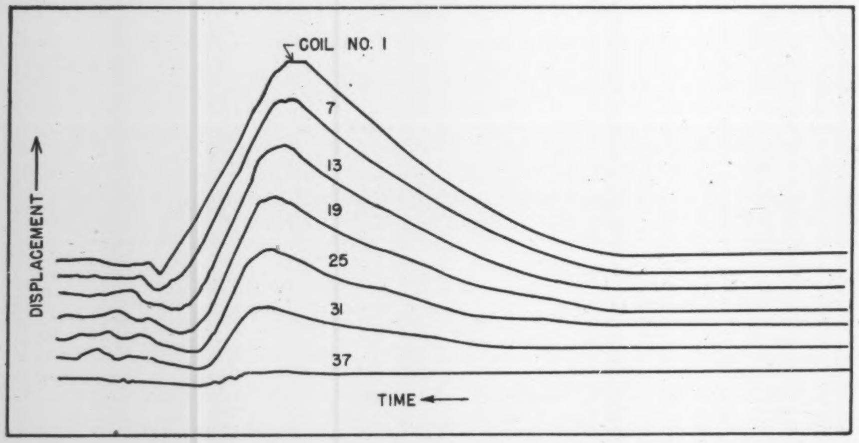
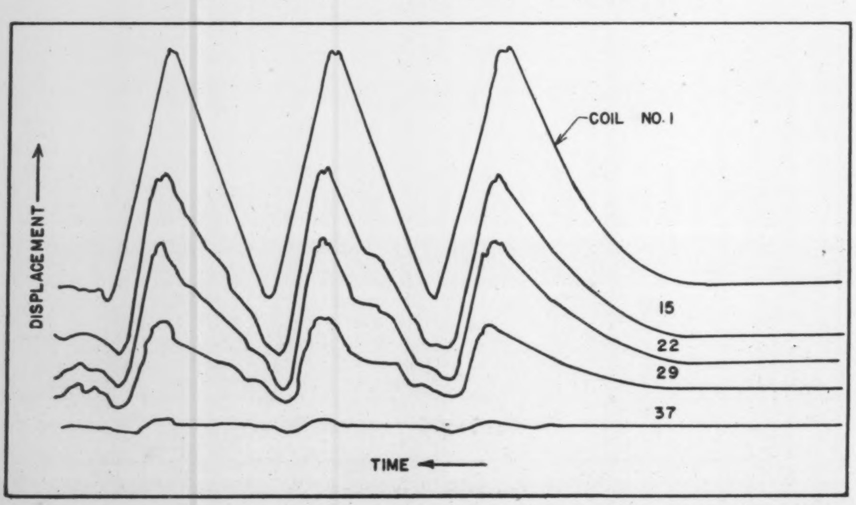


Fig. 8—Above—Time-displacement diagram for a single extension of a spring showing deflection of various coils plotted against coil movement

Fig. 9—Below—Time-displacement diagram for three extensions of a spring which clearly shows variations in coil performance



Another use for the displacement camera for the analysis of machine elements is in connection with the cathode ray oscillograph. Images formed on the screen of the oscillograph may be recorded by use of the displacement camera. The design engineer may obtain valuable information by use of cameras of the type described. Many other applications will be obvious to those who desire to study the use of this instrument.

High-Intensity Flash Replaces Shutter

HIGH-SPEED, SINGLE-EXPOSURE PHOTOGRAPHS BY REFLECTED LIGHT: The subject of high-speed, single-exposure photography will be divided into two main classes, namely, reflected light and shadow photographs. Although both types have many similar characteristics they are quite different in many respects when considered from other aspects.

In order to obtain a photograph of a machine element moving at high speed it is necessary to use extremely fast shutters. If the time the shutter is open is decreased, the light used for illuminating the object must be greatly increased. Shutter speeds on ordinary cameras are not fast enough for most high-speed photographic work. In order to use a standard camera it is necessary to arrange the camera and equipment in total darkness. By employing an intense light source having a very short time duration, satisfactory images of the moving parts may be obtained.

There are available several types of apparatus for obtaining high-intensity light flashes. A high-voltage spark gap, a Strobotac and Strobolux combination, or electronic flash tubes such as the Sylvania R4330 may be used for making extremely short time exposures. The actual types of exposure using flashes of light may be divided into two general classes; namely, single exposure, and multiple exposure.

SINGLE EXPOSURE: One of the most difficult aspects of high-speed photography is the proper synchronization of the light flash, so that the element may be photographed at the desired instant. The synchronization may be accomplished by electric switches operated by the machine, photoelectric cells, sound pickups, etc. Careful planning is often required to establish a suitable means for obtaining the flash of light at the proper time.

By means of suitable equipment, still photographs can be obtained of

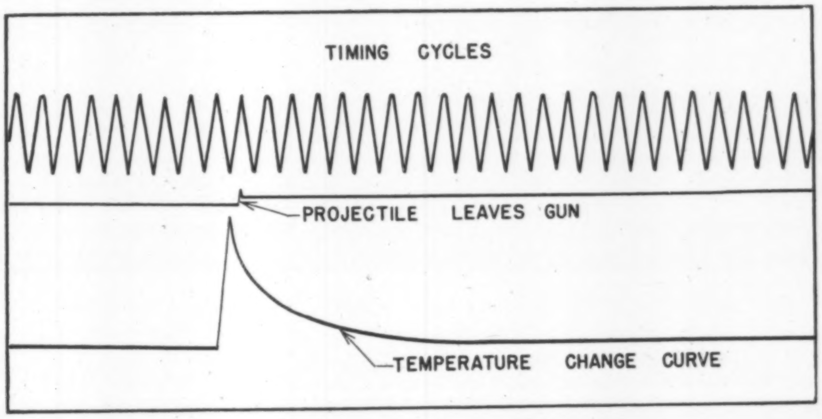


Fig. 10—Above—A typical time-temperature record obtained with a displacement camera

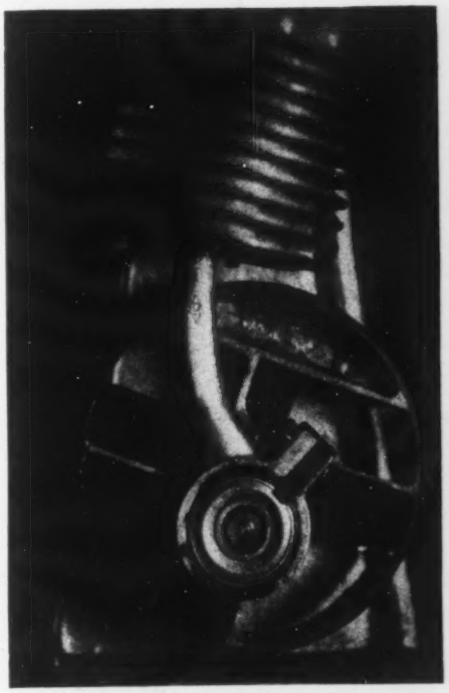


Fig. 11 — Above Right — Single-flash photograph of an air compressor operating at a speed of 1640 rpm

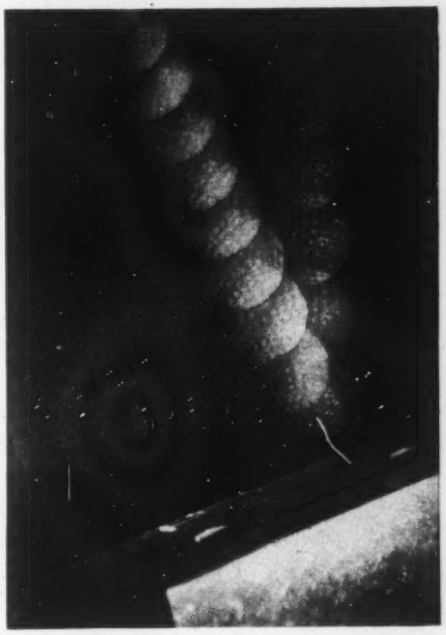


Fig. 12—Right—Multiple-flash exposure of a moving golf ball illustrating results which can be obtained with moving elements

high-speed rotating or reciprocating machine elements. Events which are transient or are nonrepetitive may be analyzed. *Fig.* 11 is a single-flash photograph taken with a standard camera, *f*-3.5 lens, using super XX film and a Strobotac and Strobolux unit. The connecting rod and flywheel of the small air compressor are clearly visible. No synchronization was used, therefore the exact position at which the connecting rod would be photographed could not be predetermined. A series of single-exposure photographs similar to the one shown could easily be obtained so that the motion of the rod could be analyzed at any part of the cycle.

Multiple Exposure: Multiple-flash exposures may be used to advantage so as to obtain more light for photographic purposes if the cyclic rate of the machine element is constant. For example, suppose that the speed of the compressor described previously was constant and a photograph of the connecting rod at the head end dead center position was desired. The strobotac flash rate could be adjusted until the crank appeared to stand still in the desired position and then a photograph taken. However, slight variations in speed cause the part to apparently rotate either counterclockwise or clockwise which causes blurring.

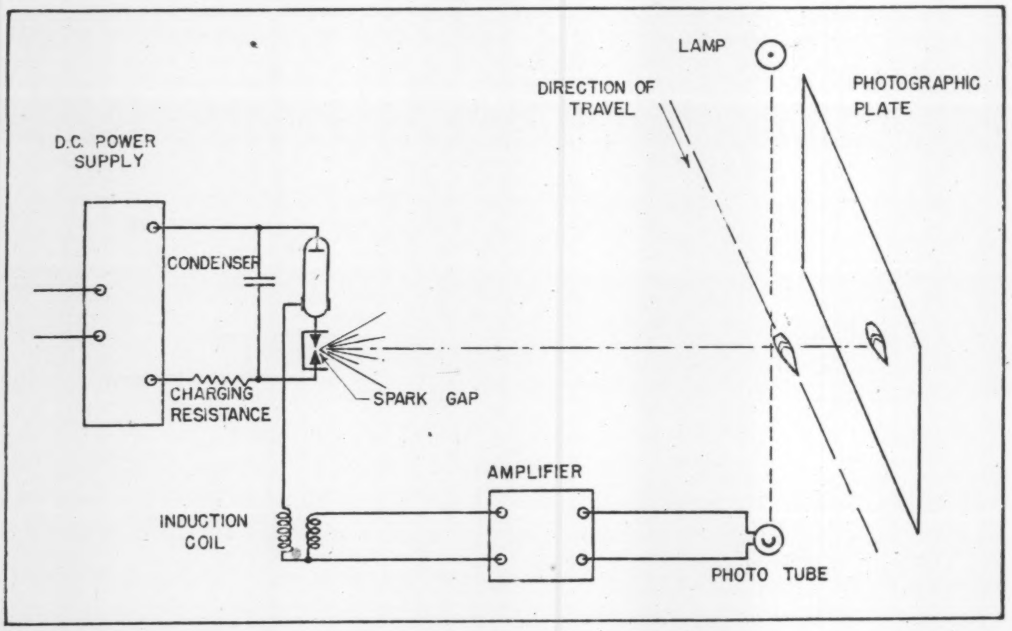
Complete Sequence of Events on One Film

For studying a nonrepeating sequence of operations of a high-speed element it is often convenient to obtain several exposures on a single plate or film. This has the advantage of recording a complete sequence of events on one film, from which plots of displacement, velocity, and acceleration can be made. The technique involved is the same as that for single-flash photographs except that some means must be provided to give a series of flashes of a specified number. Usually the camera lens is opened during the complete exposure; however, subdued light conditions are necessary in order not to overexpose the background of the film. A flash unit such as the Strobolux may be used to advantage.

Results of this method of making multiple exposures are illustrated in *Fig.* 12. The path of the golf ball as it dropped vertically and rebounded from a sloping steel plate is clearly shown. By varying the number of flashes per second the number of images may be varied. In order to obtain satisfactory negatives when using the usual flash units it is often necessary to intensify the negatives after development.

High-Speed, Single-Exposure Shadow Photograph: In the design of high-speed objects such as bullets, it is highly desirable to know something about the compressibility effects on the fluid through which the object moves. By allowing a high-speed particle to travel between a high-intensity light flash and a photographic plate, it is

Fig. 13—Right—Schematic layout of apparatus employed to shadow photograph a projectile in flight


LAMP
DIRECTION OF TRAVEL
PHOTOGRAPHIC PLATE
D.C. POWER SUPPLY
CONDENSER
CHARGING RESISTANCE
SPARK GAP
AMPLIFIER
INDUCTION COIL
PHOTO TUBE

possible to obtain a shadow of the object and a record of the disturbances in the fluid. An instantaneous flash of light is used in order to obtain a clearly defined shadow of the object. Due to differences in the index of refraction in the various parts of the fluid in the vicinity of the object a clearly defined pattern of the disturbances may be obtained on the photograph plate.

For photographing the shadow of projectiles in flight an apparatus similar to that schematically shown in *Fig.* 13 is usually employed. As the projectile passes the photographic plate, a point source of brilliant light is flashed. In order to time the flash properly, complex photocell or other electrical circuits are required. A shadow photograph of a projectile in flight is shown in *Fig.* 1. The shadow of the bullet, tail waves, and the eddies in the head and wake of the bullet are clearly visible.

Schlieren Photographs: Schlieren photographs are used to study the flow of air around heated objects, analyzing air flow, and observing compressibility effects. These photographs are sometimes called shadowgraphs; however, care should be exercised to distinguish between Schlieren photography and shadow photography previously discussed. Toepler originated this method in 1864 for observing compressibility effects. By means of this apparatus it is possible to make visible in a transparent fluid the regions in which the refractive index is slightly dif-

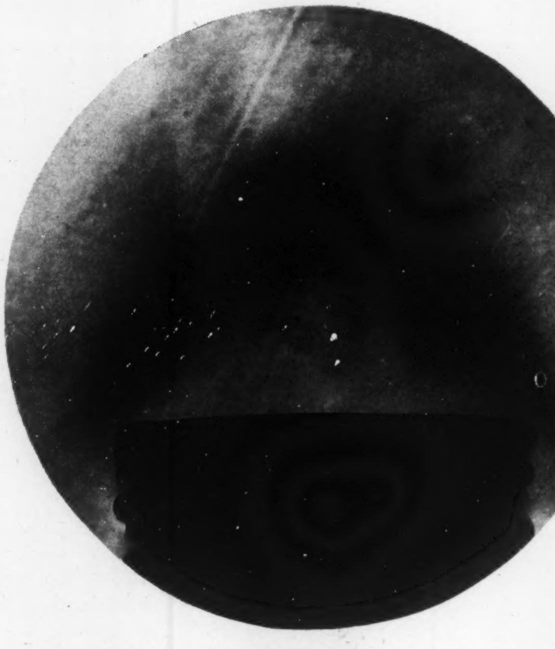
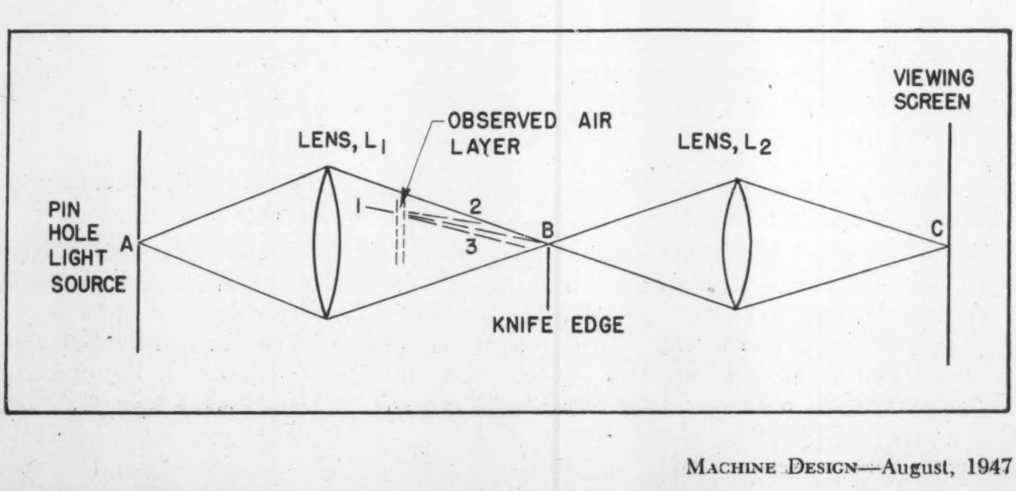


Fig. 15--Schlieren photograph of heated air movement created by a cone type heater

Fig. 14—Left—Schematic layout of Schlieren apparatus for photographing characteristics of fluids and gases


VIEWING SCREEN
OBSERVED AIR LAYER
LENS, L$_1$
LENS, L$_2$
PIN HOLE LIGHT SOURCE
A
1
2
3
B
C
KNIFE EDGE

ferent from that of the surrounding zones. The photographs which result are called schlieren, striae, or streak photographs.

In its simplest form the apparatus used consists of a point source of light *A*, lenses L_1 and L_2, knife edge *B*, and a viewing screen as shown in *Fig.* 14. As the knife edge is raised, the image on the screen will become darker. At any instant the field in general is uniformly illuminated because the image on the screen receives light from all parts of the lens L_1. A ray passing along the path from 1 to *B* would pass over the knife edge. If the density of the fluid in the small section shown changes, the index of refraction would be different from that of the surrounding fluid. Density change may result from compression of the fluid or from heating or cooling of the layer. Due to the difference in the index of refraction the ray passing from 1 to *B* will be bent up or down depending on the value of the index of refraction. If the ray is bent down the knife edge would intercept it, while if it is bent up it would pass over the edge of the blade. As a result the image as viewed on the screen would no longer be uniformly illuminated, but would consist of light and dark areas.

A cone heater, if placed between the lens L_1 and the knife edge, would cause heated air to rise. By observing the resulting image on the screen it would be possible to observe the movement of the heated air above the heater. A photograph of the image formed under the conditions discussed is shown in *Fig.* 15. Single-exposure or motion pictures may be taken of the image on the screen. In actual studies, the lenses are usually replaced by precision concave mirrors.

The second and concluding part of this article, which will appear in the September issue of MACHINE DESIGN, will cover some of the interesting developments in radiography, high-speed motion pictures and other methods.

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New Jet Bomber Employs High-Pressure Pneumatics

ARMY AIR FORCES' newest and fastest bomber, the four-jet XB-46 built by Consolidated Vultee Aircraft Corp., streaked over southern California recently on its first test flight. A high-speed, high-altitude, high-wing bomber, the XB-46 is powered by four General Electric J-35 jet propulsion engines developing a total static thrust of 16,000 pounds. Speed of the XB-46, however, is still a military secret. Two of these axial-flow jet units operate in each of the two low-slung nacelles. Simplicity of design for ease of production and maintenance is a primary feature; any engine complete with accessories, for example, can be removed and replaced by a four-man crew in half an hour. The fuselage length is 106 feet, the wing span is 113 feet, height is 28 feet and gross weight is 91,000 pounds, useful load being 42,982 pounds.

Streamlined tricycle landing gear, consisting of a single oleo-pneumatic strut with pin and socket latch, has been installed on the XB-46. Main wheels retract into a position between the two jet engines in each nacelle, and the steerable nose wheel into a well beneath the flight compartment. The Convair bomber is the first plane ever flown with a complete pneumatic system for actuation of landing gear and bomb bay doors. This high-pressure system, faster and lighter than the conventional hydraulic type, opens or shuts the snap-action bomb bay doors in a single second and fully retracts the landing gear in five seconds. The XB-46 has the world's lightest self-sealing fuel tanks, with new type gauges measuring mass instead of volume. The cabin is heated and pressurized by bleeding hot air from the four engines. The wing, with electrically-operated flaps extending almost full span, and the tail utilize exhaust gas for thermal deicing.

Compressibility of Liquids

. . . as it affects the design of high-pressure pumps and allied hydraulic equipment

By Richard L. Schmoyer
Mechanical Engineer
The Aldrich Pump Company
Allentown, Pa.

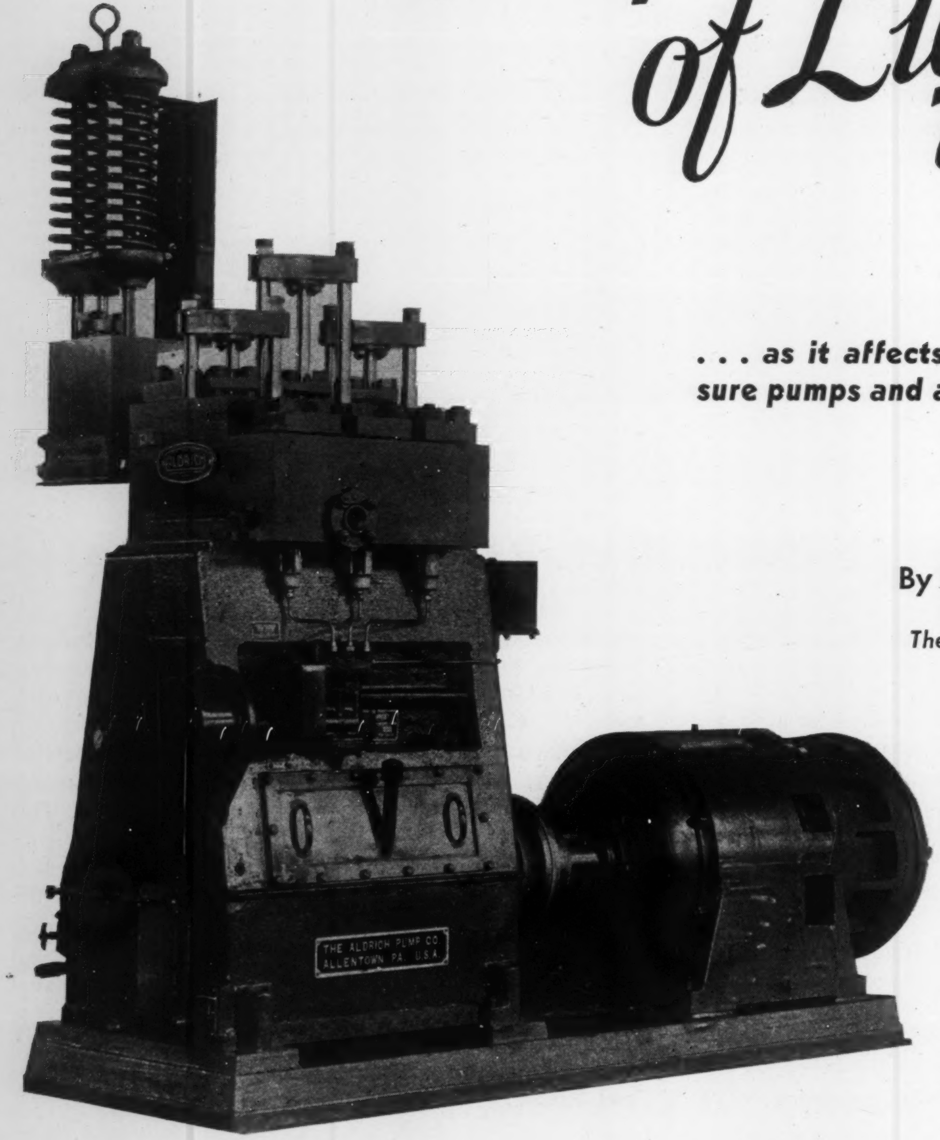


Fig. 1—Higher pressures and greater volumes of modern pumps and allied hydraulic equipment require careful consideration of compressibility

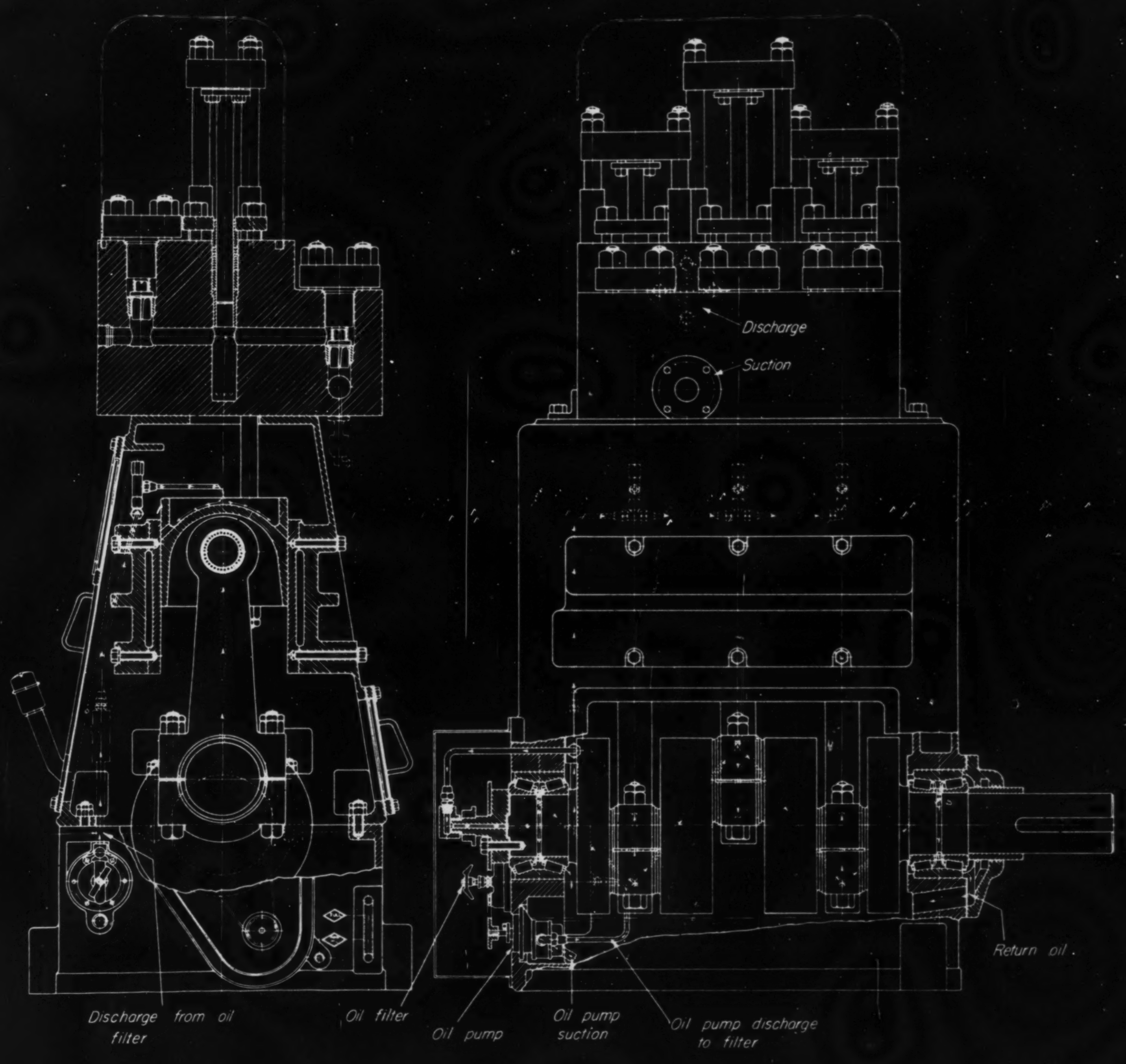
WATER and other liquids commonly used in hydraulic equipment, process plants, pipe lines, etc., and moved by positive displacement pumps are usually considered incompressible in comparison with gases and vapors which follow the various gas laws. In the design and application of pumps and hydraulic equipment for ordinary pressures, generalized calculations omitting the small compressibility factor are satisfactory. However, the higher pressures and greater volumes encountered in present-day apparatus, *Fig.* 1, increase the small factor to one of importance and require a more detailed analysis in many cases.

Pressures of 15,000 psi (approximately 1,000 atmospheres) are not uncommon in hydrostatic test equipment. Process plants employ 5000 and 10,000 psi pressures and hydraulic presses for molding and extrusion work operate with a central hydraulic power source supplying water at 3000 psi. Pipe line installations transporting crude oil and petroleum products are realizing greater economies when operated at increasingly higher pressures.

Water is more compressible under pressure than is steel or even timber within the elastic limit. Many sources of data recite the experiments of Grassi and take 0.00005 as the cubical unit-compression or the decrease in the unit of volume caused by a pressure of one atmosphere. The modulus of elasticity of volume or the bulk modulus (symbol E or k) is the ratio of unit stress to the cubical unit compression. For water, $E = 1$ atmosphere/0.00005 $= 14.7$ psi/0.00005 $= 294{,}000$ psi. The bulk modulus is usually listed as 300,000 psi for water. This value is only 1/50 to 1/100 of the value of the modulus of elasticity of volume for iron, steel, copper, brass, etc., indicating that water is many times more compressible than the common engineering metals.

The reciprocal of the bulk modulus, or the compressi-

Fig. 2—Cross sections of a typical inverted vertical Triplex type pump designed for high-pressure pumping service


Discharge
Suction
Return oil.
Discharge from oil filter
Oil filter
Oil pump
Oil pump suction
Oil pump discharge to filter

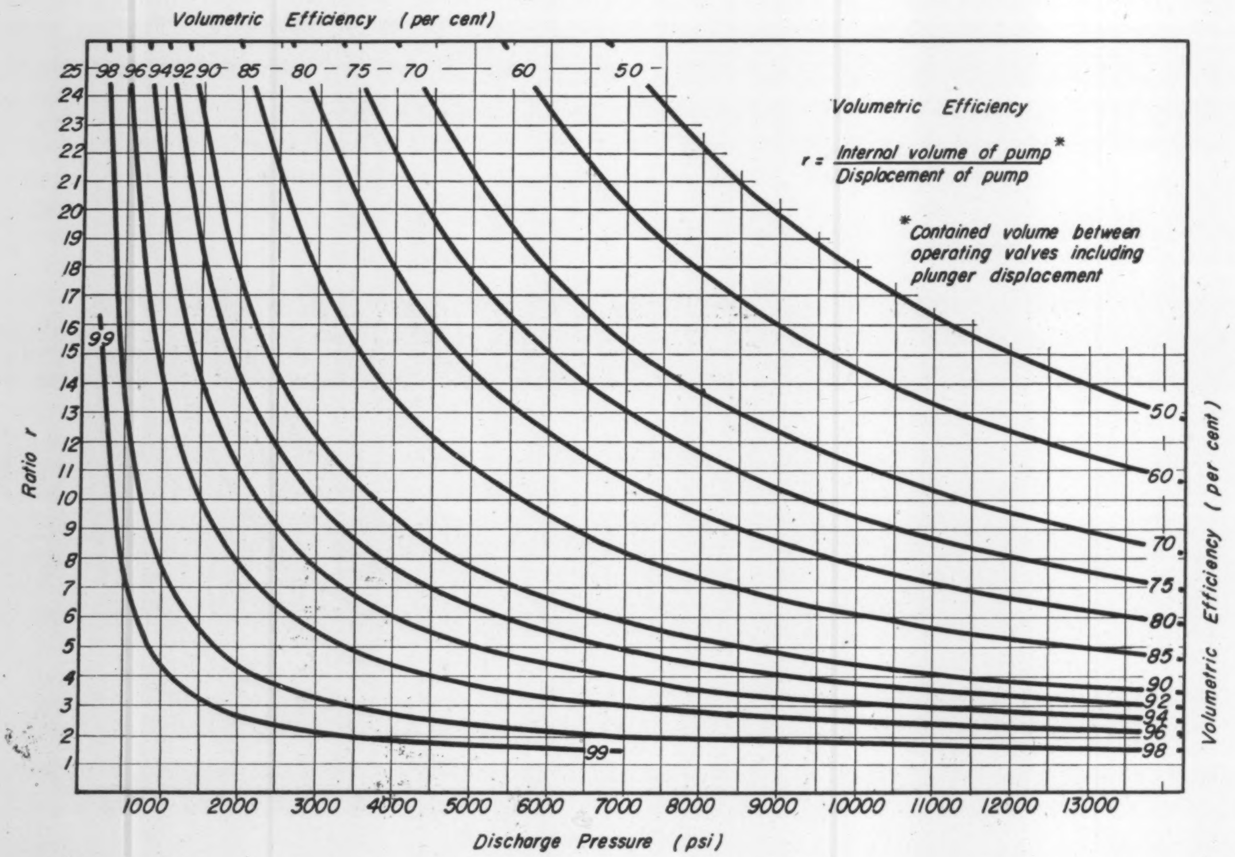


Fig. 3—Chart for readily approximating the volumetric efficiency of positive displacement pumps for water

bility factor (symbol β) is the contraction in unit volume per atmosphere of pressure.

$$\beta = dV/V \text{ per atmosphere or, } (V_2 - V_1)/V_1(P_2 - P_1)$$

where P is in atmospheres and at a given temperature. Most published compressibility factors for water and other fluids show a wide variation with temperature and a decrease in the value of the factor for increased pressures. Air or gases entrained in fluids also affect the apparent coefficient. In a range of one atmosphere, for water $\beta = 0.00005$ as indicated above or $\beta = 5.0 \times 10^{-5}$. Over a range from 0 to 1000 atmospheres (14,700 psi), which is a commonly used test pressure, the average compressibility factor $\beta = 4.0 \times 10^{-5}$ per atmosphere. For general pump application calculations at normal temperatures the following average coefficients have been found satisfactory: $\beta = 4.3 \times 10^{-5}$ for water and 7.3×10^{-5} for crude and lubricating oils. The exact compressibility figure will vary somewhat according to the pressure and temperature and where precise values or values for other liquids are desired, it is suggested that the compressibility table, Page 107 of the Smithsonian Physical Tables be employed.

This means that a given quantity of water, under a pressure of one atmosphere, will be reduced in volume 0.000043 times the original volume or 0.0043 per cent, but under a pressure of 1000 atmospheres the reduction in volume will be 4.3 per cent. For example, suppose a 20-inch ID cylindrical tank 20 feet long is to be tested hydrostatically to 25,000 psi pressure with water. This tank has a nominal volume of 75,400 cubic inches. Under 25,000 psi or 1700 atmospheres the water contained therein can be reduced in volume approximately

$$(4.3/10^5) \times 1700 \text{ atmospheres} \times 75{,}400 \text{ cu in.} = 5510 \text{ cu in.}$$

Under 25,000 psi internal pressure, incidentally, depending upon the design and proportions, the metal of which the tank is made may stretch to allow an increase in cubical content of 130 cu in. Thus to start the test, if the tank were full of water (all air bubbles removed), normally it would seem that a small addition of water should greatly increase the pressure. Actually 5510 + 130 or 5640 cu in. of water would have to be pumped into the tank to realize a pressure of 25,000 psi. A volume of 5640 cu in. or 24.4 gallons would eliminate the applicability of any hand-operated pumping equipment even though capable of 25,000 psi pressure. To do the test job in an hour would require a power pump of at least 6 horsepower capacity allowing for no leakage.

Pump Chambers Affect Compressibility

In a reciprocating plunger pump each stroke of the plunger places under pressure the volume of fluid contained around the plunger and within the fluid passages between the suction and discharge valves. This volume may be a considerable quantity in comparison with that displaced by the plunger, frequently several to over 20 times the plunger displacement, depending upon the application for which the fluid chamber is designed. The passages are proportioned to offer no restriction to the proper flow of fluid and may be even larger than necessary to accommodate a variety of plunger sizes for various pump capacities.

For a pump fluid chamber similar to the cross-section shown in *Fig.* 2, let D = volume displaced by one plunger during one stroke in cubic inches, and C = remaining volume of fluid chamber around plunger, in passages, and between valves when plunger is at the end of the discharge stroke, in cubic inches. Starting with the plunger at the beginning of the discharge stroke and the fluid chamber full of water at suction pressure, as the stroke of the plunger increases the pressure to a value P pounds per square inch or $P/14.7$ atmospheres, the total quantity of water contained will be reduced in volume,

$$(4.3/10^5) \times (C + D) \times (P/14.7) \text{ cubic inches}$$

Thus the actual discharge, assuming no back-slip through the valves, or leakage, reduced from the displacement D, will be instead

$$D - (4.3/10^5) \times (C + D) \times (P/14.7) \text{ cubic inches}$$

measured at discharge conditions. It is customary, however, to measure the quantity of water pumped after it has re-expanded in volume to that at suction pressure. The actual discharge, therefore, will be

$$D - (4.3/10^5) \times (C + D) \times (P/14.7) + (4.3/10^5) \times D \times (P/14.7) \text{ approx.}$$

$$\text{or } D - (4.3/10^5 \times C \times (P/14.7) \text{ cubic inches measured at suction pressure.}$$

The displacement D can be calculated from the plunger size and stroke. The term C can be calculated approximately by assuming the internal volume to be made up of regular geometrical shapes. For a given pump, C also can be measured by determining the quantity of water necessary to fill the passages in question when the discharge valve has been removed or through other openings in the fluid chamber, if available.

Use of the term r = the ratio $(D+C)/D$ to continue the foregoing calculation,

$$\text{Discharge} = D - [(4.3/10^5) \times D(r-1) \times (P/14.7)] \quad \text{or}$$

$$\text{Volumetric Efficiency} = 1 - [4.3\ (r-1)\ P / 10^5 \times 14.7]$$

and therefore

$$\text{Vol. Eff. (for water)} = 100 - [0.293\ (r-1)\ P / 10^3] \text{ per cent while}$$

$$\text{Vol. Eff. (for oil)} = 100 - [0.496\ (r-1)\ P / 10^3] \text{ per cent.}$$

The foregoing expressions indicate the maximum volumetric efficiency that can be obtained with zero slip through the valves. Tests of pumps indicate an additional loss due to valve slip of 2 to 10 per cent of the pump displacement, depending upon type and condition of the valves. As an example, a pump with a 5/16-inch diameter plunger and 2-inch stroke was considered for 1000 psi and 12,000 psi using water. By calculation and measurement of the fluid chamber of this pump, the ratio r in this instance = 16 and therefore

$$\begin{aligned}\text{Vol. Eff.} &= 100 - [0.293 \times 15 \times 1000/10^3] \\ &= 100 - 4.4 = 95.6 \text{ per cent at 1000 psi.}\end{aligned}$$

By actual test the pump had a volumetric efficiency of 90.7 per cent, indicating that 95.6 − 90.7 = 4.9 per cent loss was attributable to valve slip and leakage. At 12,000 psi,

$$\begin{aligned}\text{Vol. Eff.} &= 100 - [0.293 \times 15 \times 12000/10^3] \\ &= 100 - 52.7 = 47.3 \text{ per cent.}\end{aligned}$$

Tests showed only 41.0 per cent volumetric efficiency which alone might suggest faulty valves, leakage, or other correctable difficulties. Knowing, however, that the compressibility of the water together with the geometry of the pump interior allow a maximum of only 47.3 per cent volumetric efficiency, the valve operation can be considered reasonable since the valve loss increased from 4.9 per cent to only 6.3 per cent (47.3 − 41.0 per cent) at the greater pressure.

Another pump with 1¼-inch diameter plungers, 6-inch stroke and r = 13.4, delivered 87.8 per cent of the plunger displacement at 2500 psi discharge pressure. The limiting volumetric efficiency,

$$\begin{aligned}\text{Vol. Eff.} &= 100 - [0.293 \times 12.4 \times 2500/10^3] \\ &= 100 - 9.1 = 90.9 \text{ per cent}\end{aligned}$$

indicated a loss of 90.9 − 87.8 or 3.1 per cent through valves, etc.

This same pump, when fitted with ⅞-inch diameter plungers for 4000 psi service, developed only 64.6 per cent volumetric efficiency by test. The decrease in plunger size, with no change in the volume of the fluid passages, gave the new pump a ratio r = 27.1 which resulted in a calculated volumetric efficiency,

$$\begin{aligned}\text{Vol. Eff.} &= 100 - [0.293 \times (26.1) \times 4{,}000/10^3] \\ &= 100 - 30.6 = 69.4 \text{ per cent}\end{aligned}$$

Valving, etc., were considered satisfactory since the corresponding losses accounted for only 69.4 − 64.6 or 4.8 per cent at 4000 psi as compared with 3.1 per cent at 2500 psi. The accompanying chart, *Fig.* 3, can be used to approximate the volumetric efficiency of a positive displacement pump using water and knowing the ratio r applying to the pump.

In the design or application of any hydraulic apparatus such as pressure vessels, piping, pumps, presses, etc., in which the quantity of fluid contained is of importance in regard to the operation of the equipment or to other factors, the safe procedure is to calculate the actual change of volume produced by the application or the release of pressure before assuming that the volume change is of little consequence. Average compressibility factors for fluids mentioned in this article were summarized from published data listed below.

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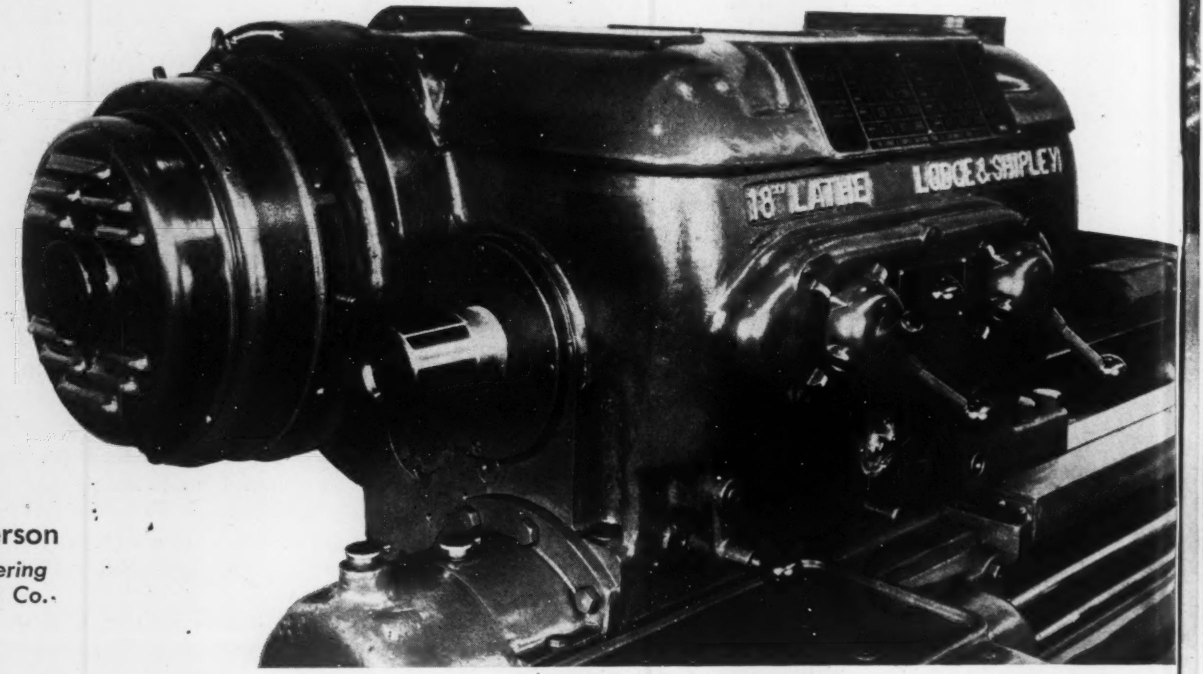
Smithsonian Physical Tables.

Unique Motor Utilizes Pancake



By G. R. Anderson
Director of Engineering
Fairbanks, Morse & Co.
Beloit, Wis.

Fig. 1—Ten-horsepower motor applied to headstock of lathe, showing suitability of short axial length of motor for flange mounting

DESIGN of machines and mechanical parts invariably involves the solution of many problems of fabrication. An interesting case where such problems were intimately associated with design is represented by the axial air gap motor illustrated in *Fig.* 1 and developed by Fairbanks, Morse & Co. Named for the form of its magnetic core, this motor has its air-gap length (distance between stator and rotor) parallel to the axis of the shaft, thus the term "axial air gap." In a conventional electric motor, of course, the air-gap length is radial with respect to the axis.

From the electrical standpoint the design concerns itself with the fabrication of a magnetic core in the form of thick steel disks, *Fig.* 2, the development of distributed stator winding in the form of a circular sector, and the fabrication of a disk-type squirrel-cage rotor on a production basis.

From the standpoint of mechanical design, a number of innovations have been incorporated that differ markedly from conventional electric motors. In the first place, means have been developed to fasten the magnetic core of both the rotor and the stator to the supporting structure. Second, the fact that the air gap is parallel to the axis of the shaft requires that all manufacturing tolerances must be controlled from length dimensions rather than radial or diametric. A third consideration, the method of supporting the bearings, has been ingeniously worked out in the form of an inside frame. Development of the inside frame contributes in a large measure to the ability to control lengthwise tolerances and thereby maintain a constant and rigid air gap. These design features are shown in cross-sectional view in *Fig.* 3 and will be discussed later. Component parts of a complete assembly are illustrated in *Fig.* 4.

Electrical Design

Design of the magnetic core from electric strip steel required the development of machinery to punch and coil the strip automatically in such a way that the slots would line up radially or skewed, as desired. Inserting distributed field windings, *Fig.* 5, to form the primary winding of the induction motor presented no particular design or production difficulties, provided the dimensions of the core were selected to permit sufficient room for the inner coil extensions. Experience further proved that the

Design

magnetic core in the form of a thick plate permitted the operator to better see and perform the operations of inserting coils. The work of inserting coils, being out in the open, further permitted the development of improved and simplified machinery for coiling and inserting simultaneously. In other words, what might appear on the surface to be a difficult problem actually became an unusually simple production method.

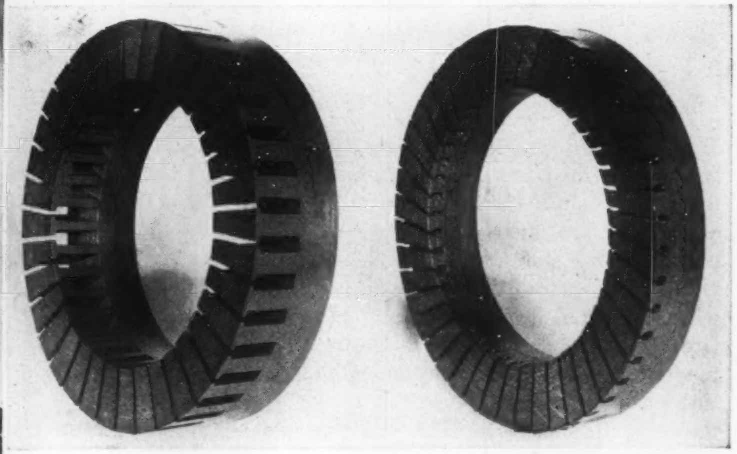


Fig. 2—Above—Stator and rotor cores are wound from punched strip steel. Stator core, left, has radial slots for insertion of coils and rotor, right, has skewed slots, the bars for which are cast in centrifugally

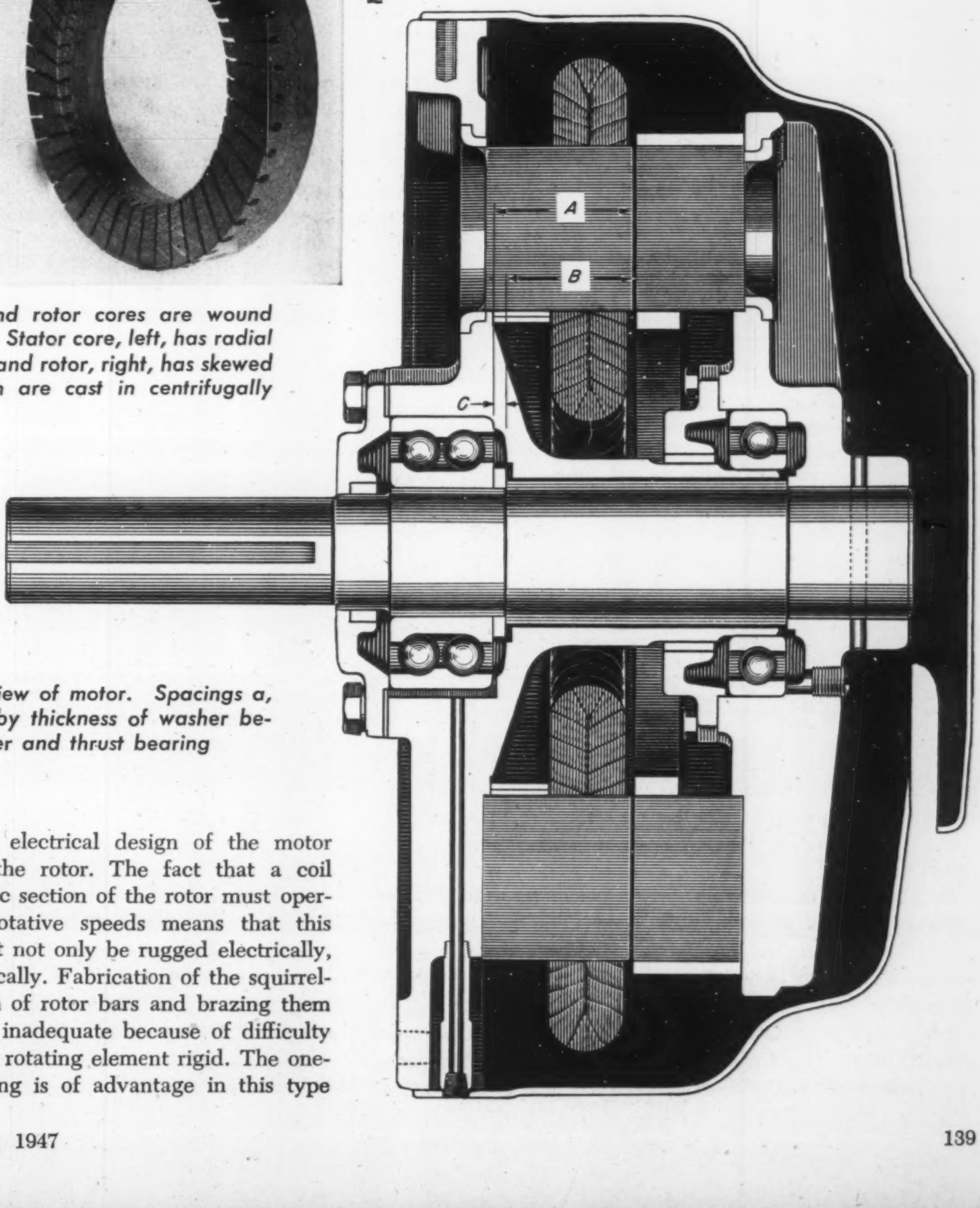


Fig. 3—Right—Sectional view of motor. Spacings a, b and c, are controlled by thickness of washer between shaft shoulder and thrust bearing

Another factor in the electrical design of the motor was the fabrication of the rotor. The fact that a coil strip forming the magnetic section of the rotor must operate at relatively high rotative speeds means that this part of the structure must not only be rugged electrically, but also be rigid mechanically. Fabrication of the squirrel-cage winding by insertion of rotor bars and brazing them to end rings is obviously inadequate because of difficulty in making all parts of the rotating element rigid. The one-piece squirrel-cage winding is of advantage in this type of motor, and either aluminum or copper may be utilized for the rotor windings. The use of copper, fabricated by the copper-spun (centrifugal casting) process, permits higher rotative speeds and has the advantage of using a high-conductivity material, keeping the thickness of the rotor to a minimum.

Mechanical Design

Mechanical design and construction of the motor include a number of interesting features. The first and most important is the method by which the stator and rotor magnetic cores are assembled to their supporting frame and spider, respectively. Use of rivets, studs or screws is out of the question by the very nature of the structural assembly. Welding is one form of assembly that can be used, but it also presents difficult production problems.

For example, if electrical welding is applied to a steel core, supporting it to the frame to secure good bond, the frame should be steel. Welding a steel frame to the core causes warping which means that machining accuracies

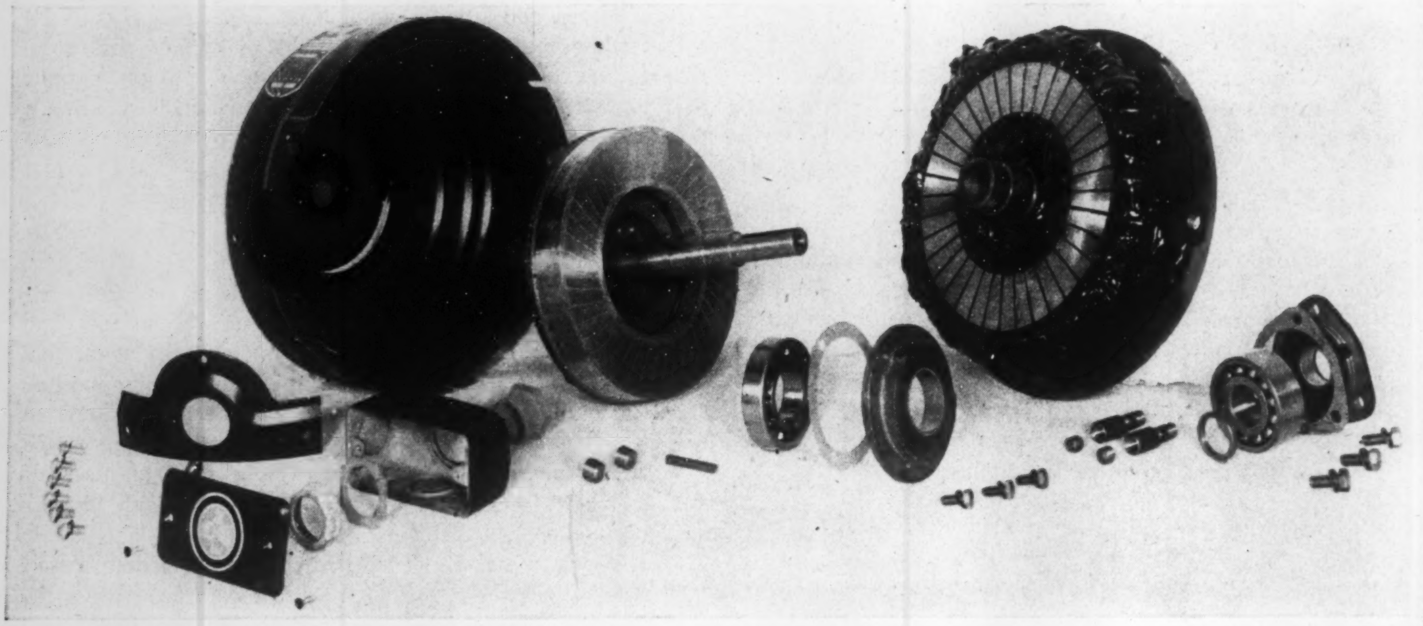


Fig. 4—Component parts for motor assembly

are destroyed or remachining is required. This design problem was overcome by the development of cast-iron frames and spiders with steel-ring inserts so designed that the weld of the core to the frame is steel to steel, *Fig.* 6. Shrinkage of the welds simply tightens the insert rings in the casting. Welding in this manner eliminates the distortion or warpage usually encountered, thus obviating remachining of assembled units.

Another method of assembling cast-iron frames to steel cores employs arc brazing. The reduction of temperatures in brazing, compared to welding, and the ease of fabrication of this material has permitted the use of this method of processing in the assembly of steel cores to cast structures, *Fig.* 7.

COMPARISON WITH CONVENTIONAL MOTORS
(1800 RPM Motors)

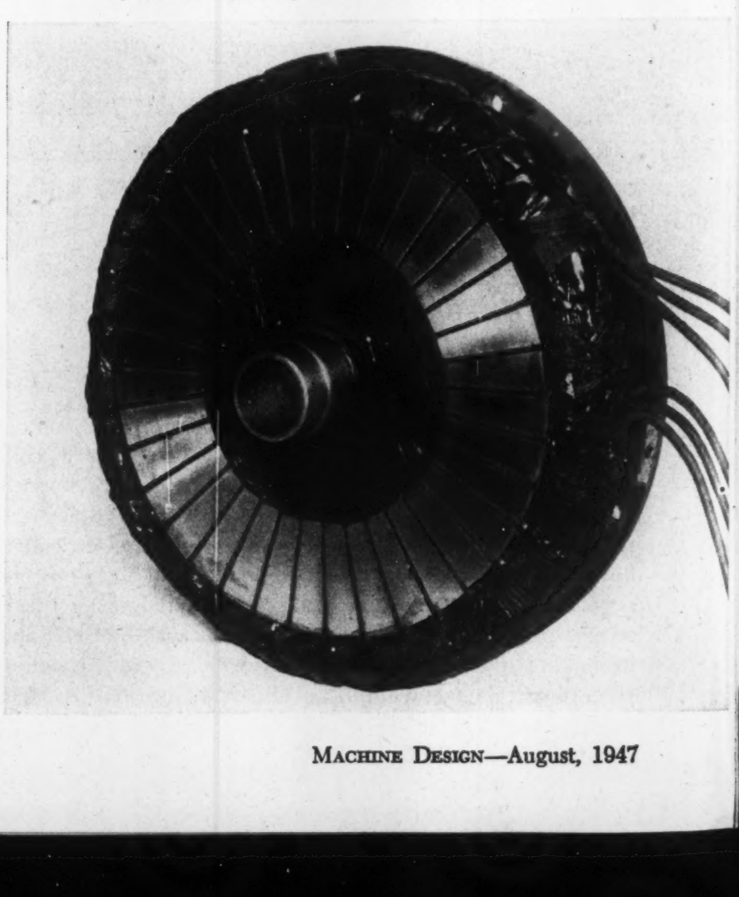
Rating (hp)	Type of Motor*	Rotor Inertia (lb-ft²)	Weight (lb)	Diameter (in)	Length (in.)
1	AAG	1.0	41	10⅜	6⅛
	Con	0.37	61	9⅝	11⅞
2	AAG	2.3	70	12⅜	6 13/16
	Con	0.50	97	14⅛	13⅞
5	AAG	7.0	106	10⅞	8 3/16
	Con	1.4	174	12⅛	16⅞
10	AAG	13.0	178	16⅜	9 9/16
	Con	4.0	332	15¾	21 1/16

* AAG = Axial air gap motor; Con = conventional motor

As shown in the cross-sectional view of the motor, *Fig.* 3, both bearings are supported by the member that supports the stator core. The bearing adjacent to the shaft extension in conventionally mounted and rigidly fixed in position. It is a double-row preloaded bearing capable of carrying thrust in either direction, thus the position of this bearing fixes all lateral positioning of the shaft. A tubular extension of the stator frame through the center of the coils is provided to carry the free, or rotor end, bearing. This bearing has an outer rotating race, the inner race being stationary and supported on the frame extension. The motor shaft extends through the hollow portion of the stator frame into the rotor bearing.

The reason for such a design will become apparent when the problem of controlling axial dimensions is taken into consideration. First, it is desirable to select one surface from which all dimensioning will be controlled. In this case, the surface selected is the inner face of the thrust bearing support. Thus all dimensioning starts from this point. From the rotating element, the shoulder on the shaft supporting the inner face of the thrust bearing is

Fig. 5—Stator complete with windings. Because of open face in slots, coils can be wound and inserted in a single operation, greatly facilitating production



the basis for all rotor dimensioning. It will, therefore, be seen that dimensions *a*, *b*, and *c* in *Fig.* 3 will control the length of gap in this type of motor.

Dimension *a*, the distance from the bearing shoulder in the frame to the face of the stator, is measured by dial depth gages in the facing operation of the stator after the unit has been wound and assembled. Dimension *b* is controlled by dial depth gages in the finished facing of the assmbled rotor. Dimension *c* is the thickness of a washer and, by varying this thickness, different gap dimensions of the motor may be obtained without changing any other dimensions. It is interesting to note that this is the only motor in which the dimensions of the air gap can be easily changed without affecting the magnetic dimensions of the motor and it has been used as a means of investigating effect of gap distance on stray load losses of squirrel-cage induction motors.

Construction of the inside frame serves to materially reduce the weight of the motor. It eliminates the necessity for a conventional frame and bracket support of the bearings. Covers or coil guards can be fabricated from sheet steel, aluminum or other light metals, since they perform no function in the structural support of the motor other than to protect the coils and guide ventilation.

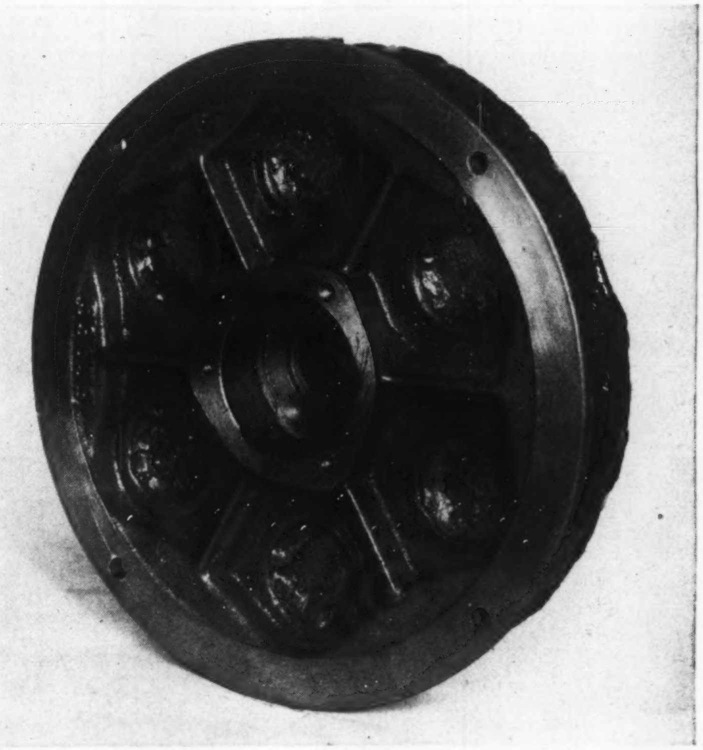


Fig. 6—Frame has cast-in steel inserts which are welded to stator core, facilitating welding and minimizing warping

There is a magnetic thrust between the surfaces of the stator and the rotor which determines the size of thrust bearing used. This thrust is of the order of 12 to 14 pounds for each square inch of air-gap surface. The use of a fixed thrust bearing means that there is no end play to a motor of this type, a feature that is often demanded of conventional motors.

Weight and size comparison with conventional motors as well as comparison of inertia (WR^2) values of the rotor is shown in the accompanying tabulation. The higher WR^2 of the axial air gap motor makes it adaptable for punch presses, oil well drilling rigs, and similar applications. It is not desirable, however, where repeated reversing is required.

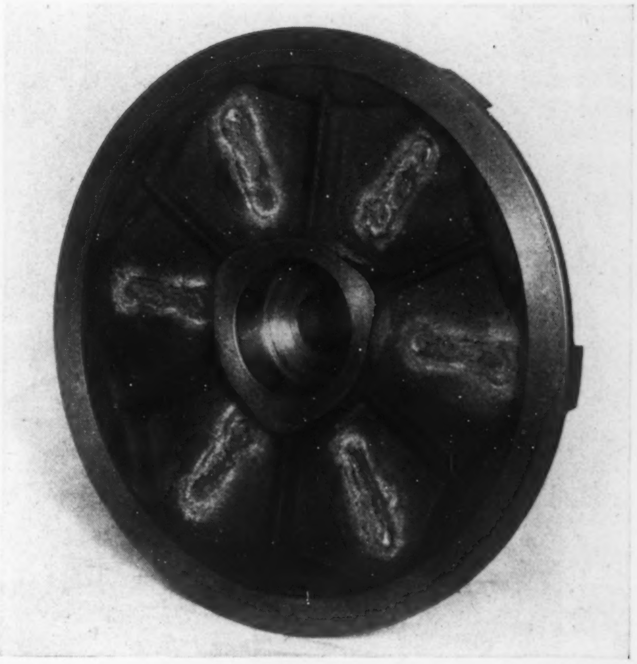


Fig. 7—Alternative method of joining stator core to frame by means of arc brazing in slots

Mounting Features

Construction of this motor makes it useful as a flange-mounted unit. *Fig.* 1 illustrates an application where streamlined appearance and simplicity of mounting is apparent. By the simple expedient of a three-point suspension on a right-angle pivot base, this type of motor can be used for conventional belt drives. Where belt drive is required on machine tools, a similar mounting can be made on the face of the machine instead of supplying a platform for support of conventional motors.

Reduction in size and weight of the axial air gap motor over corresponding conventional motors has not been obtained by reducing the effective amount of copper or magnetic steel, nor by raising temperatures. It has been made possible by the disk structure and the use of an inside supporting frame. This inside frame contributes in a large measure to reduction of weight without sacrifice of strength, performance or rigidity. There is also a reduction in the amount of scrap steel in that there is no corner waste as in the conventional motor. The amount of steel required for motors of various speeds (number of poles) can be selected to best advantage since it is not subject to the fixed diameters of conventional motors.

CORRECTION: Damping equation terms in the article "Comparing Plastics," July, Page 115, contained a regrettable typographical error. Equation and terms should have read: Percent damping, ψ, is defined as

$$\psi = (E_a/E)100$$

where E_a equals the energy absorbed per cycle, and E equals the energy content at the start of the cycle.

Rate-Detecting Gyro

. . . for measuring changes in velocity utilizes electromagnetic pickup

By Victor J. Canziani
Project Engineer
Fairchild Camera and Instrument Corp.
Jamaica, N. Y.

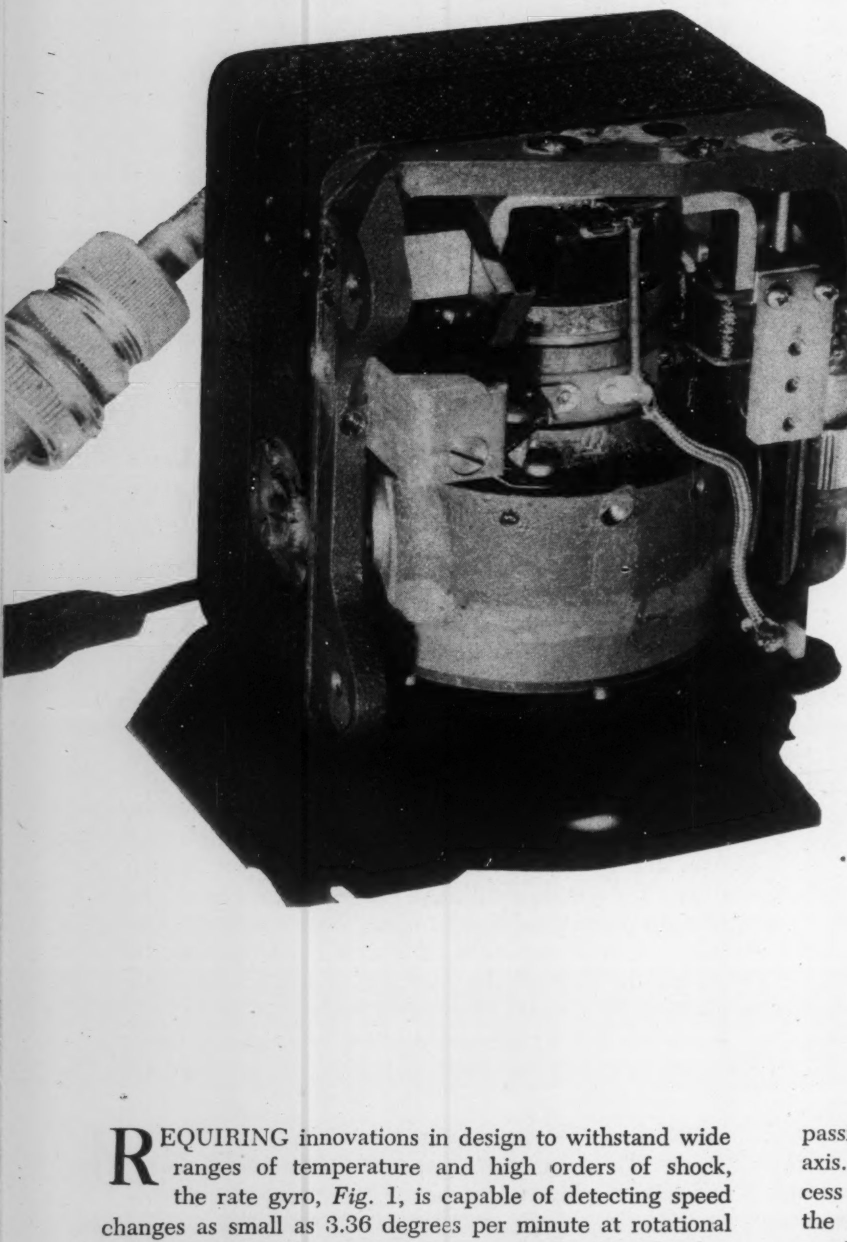


Fig. 1—Above—Rate gyro with cover removed. Large circular mass at bottom is motor housing. Coils for induction take-off are visible at right side just in back of terminal strip. Damping magnet is at upper left of unit

REQUIRING innovations in design to withstand wide ranges of temperature and high orders of shock, the rate gyro, *Fig.* 1, is capable of detecting speed changes as small as 3.36 degrees per minute at rotational velocities as high as 1800 degrees per minute. This has been achieved by the careful use of dimensionally-stable metals and materials such as plastics, a novel system of plastics-bonding of transformer laminations—instead of riveting—and an electromagnetic pickup in the device.

Small size and high sensitivity have made the rate gyro applicable to a variety of machine applications. These include: Speed control of large powered machines such as turret lathes, rate measurement of the angular movement of gun turrets in fighting planes in conjunction with computing gunsights, and certain types of angular-velocity indicators and accelerometers.

Like a conventional gyroscope, the rate gyro has its spinning member, or rotor, set in a mount, but one with only a single plane of freedom. The external torque axis, to be effective in causing precession, is set at right angles to both spin axis and gimbal axis. In this manner the gyro rotor moves, or precesses, in a plane passing through its spin axis and parallel to the torque axis. If the gyroscope were unrestrained it would precess 90 degrees until the spin axis became parallel to the torque axis. The rate gyro, however, has the precession restrained by a pair of precise springs. The system has been so designed that within the limited precession angles used the angle is proportional to the disturbing force. Thus, when the gyro is mounted so that the entire unit is rotated about an axis perpendicular to both the spin and gimbal axes, the precession is in proportion to the angular rate at which the gyroscope is moved about the external axis.

The gyro motor is coupled through two series-mounted tension springs to the gimbal frame as shown in *Fig.* 2. Through design control, it is capable of detecting rates up to 30 degrees per second or 1800 degrees per minute. The detection of the amount of precession is taken out through an inductive take-off having the main or fixed section mounted to the gyro gimbal frame, and the moving section mounted on the gyro motor housing. The take-off is excited from a 400-cycle ac supply, and the output voltage is directly proportional to the precession of the gyro motor housing in relation to the fixed member. Direction sense on either side of the neutral position is determined by the phase-change characteristic of the take-off. Thus, the take-off system is a form of variable air-gap transformer.

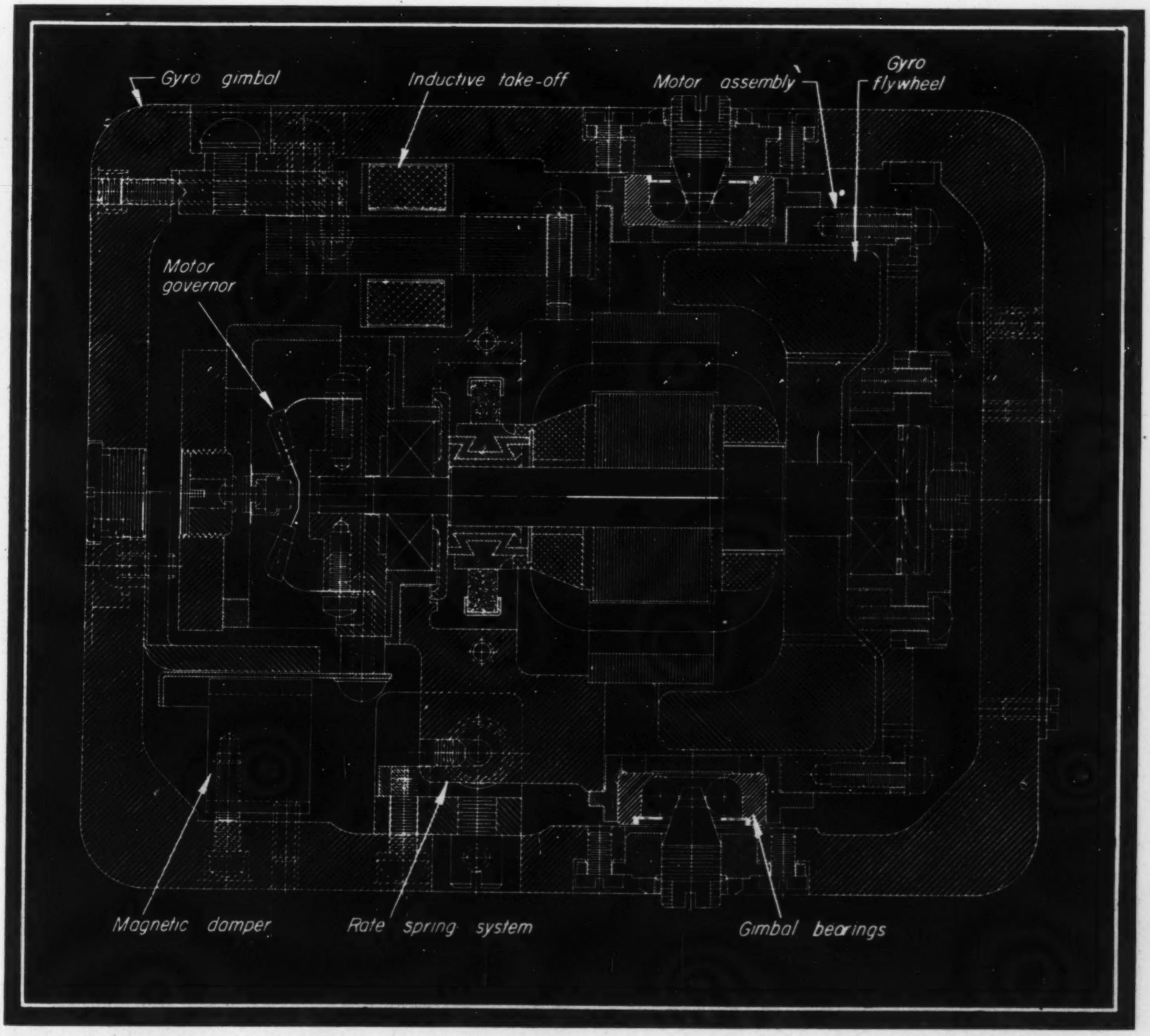
DETAILS OF DESIGN: The electromagnetic circuits in the gyro consist of a three-legged magnet, *Fig.* 3, in the shape of an E, containing primary (energizing) coils on the middle leg and secondary (output) coils on the two outer legs.

These primary and secondary coils are wound around Nylon bobbins. Since the E-magnet is one of the most strategic parts of the rate gyro, it is important for its coils to have physical stability for high performance. To achieve good accuracy the mating radius faces of the take-off fixed member and its associated moving member are ground to a tolerance of 0.0002-inch. Once set up within the gyro and calibrated, they must be maintained continuously in relation to each other. If any distortion should take place, so that the fixed member of the take-off displaces with respect to the moving member, the electrical output of the take-off will not be continuously dependable.

Laminations Plastic Bonded

Laminations in the magnetic take-off system are stack assembled by use of a plastic bonding method which eliminates all use of rivets for stack-up assembly purposes. The main objective is to minimize electrical losses in the magnetic circuit. At the same time, sufficiently strong bonds are obtained to withstand the grinding operations necessary for finishing the pole faces to ±0.0002-inch tolerance. These bonds are also resistant to thermal shock

Fig. 2—Cross-sectional drawing through gyro clearly illustrates method of functioning



in both cold (−65 degrees F) and heat (+160 degrees F).

As previously mentioned gyro precession is limited to one plane of freedom and is restrained by a carefully balanced rate-spring system. Undue oscillations are reduced by a permanent-magnet unit. Since the spring deflections are proportional to speed changes it is essential that the spring constants be uniform. For this reason micro-processed beryllium copper springs are used in the system. In addition, oscillatory motion induced about the gimbal axis and caused by spring vibration after sudden changes in rates, is damped out by an eddy-current damping system employing Alnico V permanent magnets. The poles of these magnets are soldered into place and ground-finished after low temperature soldering with a eutectic solder, losing only a minimum (1 to 3 per cent) of the magnetic properties found in the Alnico magnet stock before working.

Close Speed Control Vital

An important factor is that the motor speed be maintained. Precession in a rate gyro, when all the design factors have been established, is proportional to the rotor speed. Drift in rotor speed will cause the precession to vary accordingly, producing proportional errors. Therefore, the motor speed is governor controlled to plus or minus 65 F to plus 160 F, in order to maintain accuracy of precession. The operating input currents are low: being approximately 0.3-ampere at 24 to 30 volts dc.

Fig. 3—Partial disassembly of gyro shows wide use of plastics. To left of illustration is brush assembly and its plastics elements, while to right is shown magnetic take off assembly and its parts. Coil form has unusually thin sections

Materials: Magnesium alloys are used for the various cast parts of the gyro. Full advantage of their properties is obtained through heat and stabilization treatments, the latter treatment being given between rough and final machining. Other suitable metals such as stainless steel are employed, where required, to establish stable conditions.

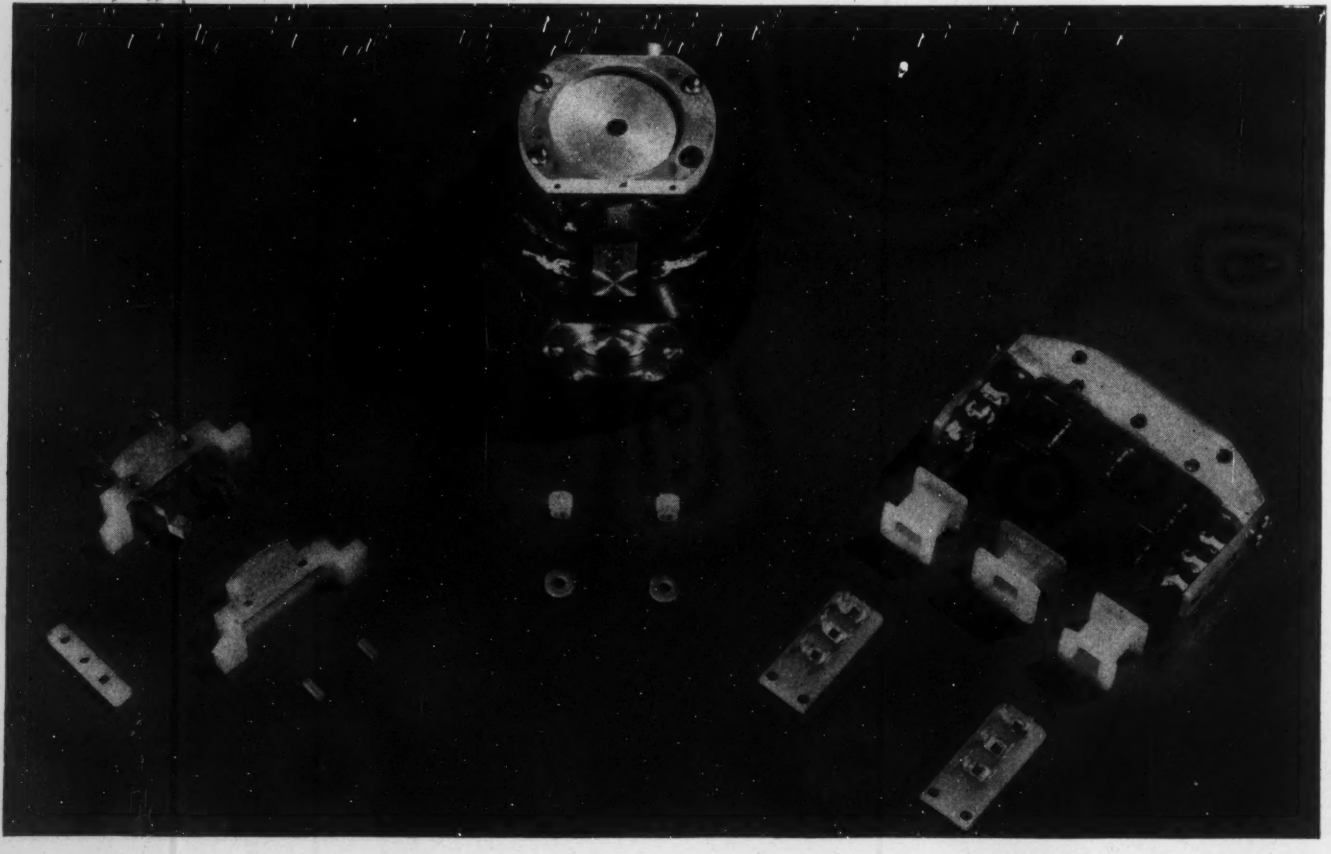
Nylon Solution to Material Problem

Molded Nylon parts, *Fig.* 3, are used extensively for coil forms in the take-off system, as well as for motor brush-holder, terminal boards, electrical insulating bushings, insulators, etc. The high durability of this material, its stability—especially for coil forms—and high heat resistance as well as apparent fungus resistance were among the factors determining the selection of Nylon.

Evolution of the design of the rate gyro led naturally to the use of Nylon in various locations. It retains its shape without becoming brittle under the temperature extremes. Further, it can be molded into the small, complex shapes demanded in this tightly-packed gyro, which weighs less than three pounds and measures four inches or less in each of its three dimensions.

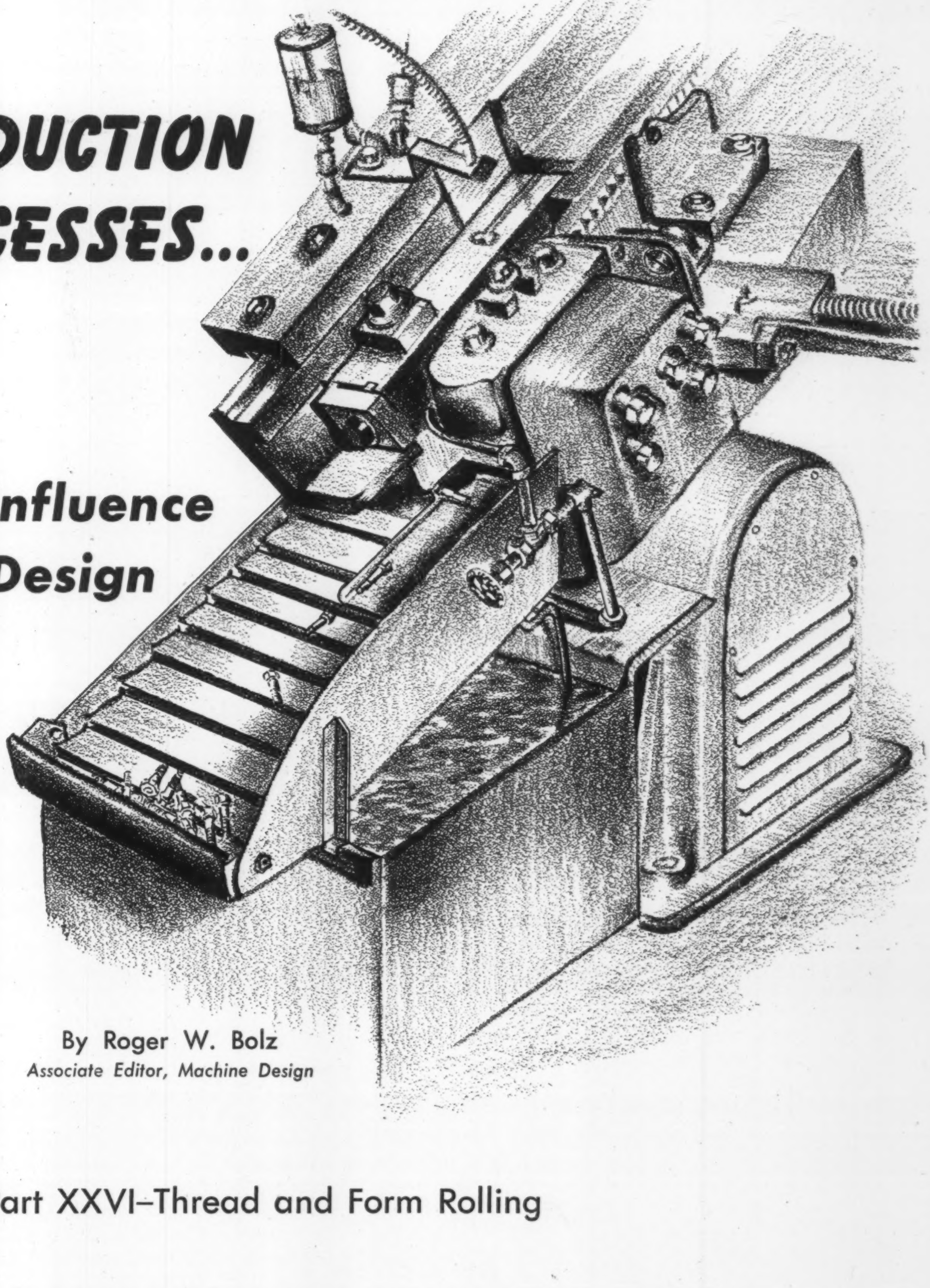
Nylon has permitted the injection-molding of these parts at a low cost compared to that which would have resulted with machining. Some of these parts are extremely intricate in design, and are molded to tolerances of less than 0.005-inch.

The complete gyro is sealed against tampering by one of the strippable plastic films. One of the physical characteristics of these materials, in addition to others, provides a good visual detection means for tampering inspection. In addition, the plastic film provides a good seal againsr the entry of dust or other foreign matter.



PRODUCTION PROCESSES...

Their Influence On Design



By Roger W. Bolz
Associate Editor, Machine Design

Part XXVI–Thread and Form Rolling

ROLLING of screw threads and other circular forms between suitable hardened steel dies, known and practiced for well over a hundred years, has today reached a high degree of perfection. Originally classed merely as an extremely high-production process, thread and form rolling now offers not only unusual production speed but also precision comparable to that of fine grinding, as well as wide versatility. With the introduction of cylindrical-die thread and form rolling machines during the past five or six years, the economies and other practical benefits of cold rolling can now be obtained on a range of design applications sufficiently broad to make its consideration as a primary production method imperative.

Essentially a forging process, thread and form rolling produces the finished part by displacement of metal to conform with the contours of the dies employed. Two distinct methods for accomplishing this end are in use today, the flat-die and the cylindrical-die methods. In the older and more common method, a cylindrical blank is placed between two flat hardened-steel dies—into the exposed faces of which is machined a negative impression of the desired form pattern—and as one die is moved past the other the proper profile is impressed onto the blank, *Fig.* 1. No material whatever is removed from the original blank. The diameter of the finished part is determined by the distance between the faces of the dies at the end of the stroke. As can be readily seen, the work is formed, or forged, at a fixed cycle of penetration which is limited and controlled by the diameter of the part and the length of the dies.

In the second and most recent method of rolling, cylindrical dies are employed having negative multiple threads or a negative impression of the form pattern which is desired, *Fig.* 2. Driven synchronously at a predetermined speed on parallel shafts, the dies—either two or three—are actuated to feed in automatically to the desired finished diameter and then withdraw. As with the flat die method, the entire formed length is rolled at one time but, inasmuch as the cylindrical dies present in effect die surfaces of infinite length, the penetration cycle can be varied to suit the particular requirements of the workpiece.

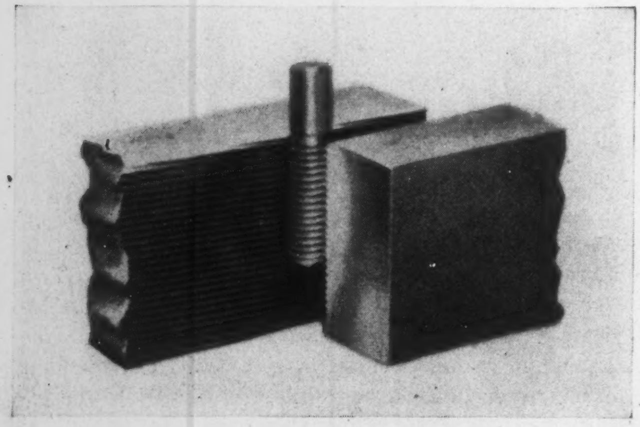
Fastest Method of Forming Threads

As mentioned in Part XIII of this series, thread rolling is undoubtedly the fastest and most efficient method of forming threads and is a valuable adjunct to the cold heading process, *Fig.* 3. The same is true even where contours or forms other than standard threads are concerned. Too, thread rolling is often employed in automatic screw machine work (see Part III of this series) to speed up output.

Recent advances in the technique of rolling have overcome many of the previous limitations common to thread rollers and it is now practical to roll precision threads and forms on hollow cylinders, short lengths, tapers, large diameters, etc., using any of a wide range of materials, *Fig.* 4. In addition, awkward or top heavy parts, *Fig.* 5, normally impractical for the flat-die machine, are readily handled with the triple cylindrical-die machine.

There are several types of machines available employing each of the rolling methods mentioned—reciprocating flat-die, rotating twin cylindrical-die and rotating triple cylindrical-die. Flat-die machines are of the inclined variety to provide automatic feed and gravity ejection, horizontal machines for hand-fed work, and side-feed machines for special long work which requires a horizontal position, and are particularly well suited to the production of the more simple types of fasteners and forms, *Fig.* 6. On symmetrical threaded parts such as these up to about 1-inch in diameter, threads below ¼-inch, designs such as gimlet point screws, knurled parts under 1-inch diameter, etc., the flat-die machines excel in output speed and adaptability. Normally these machines are limited to maximum diameters of about 1.125-inch although diameters up to 1.500-inch have been produced successfully. The lower diameter limit is generally around 0.060-inch but here again threads as small as 0.006-inch have been made successfully. Maximum length of rolled portion is limited primarily by the die face width on flat-die machines. This dimension runs from 0.500-inch on the smallest machine to around 8 inches on the largest machine. Die lengths run from about 1.750-inch on the smallest machine to about 15 inches on the largest.

Fig. 1—Below—Die arrangement used in flat-die rolling



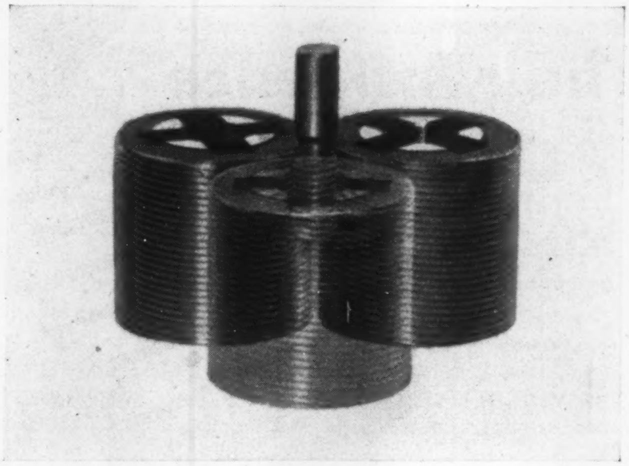


Fig. 2—Die arrangement used in cylindrical-die rolling. Two rolls with a center rest are also used

Cylindrical-die machines normally are adjustable over a wider range of diameters than are flat-die machines but are not suited to the rolling of diameters under ¼-inch, ⅜-inch being a commonly accepted lower limit. These machines are also manufactured in both horizontal and vertical types with the maximum practical diameter which can be handled being about 4 inches although in certain cases this can be upped to 6 inches, *Fig.* 7. Maximum length which can be rolled in one pass ranges up to 6 inches and is dependent upon the face width of dies which can be employed in the particular machine used.

As in all cold-forming operations, the product of the thread-rolling machine is superior to that produced by machining. Tensile and shear strength as well as fatigue resistance of the rolled parts is increased to a marked degree. To these advantages are added those of a smooth, hard burnished surface and the ability to produce accurate threads and forms on soft, tough and stringy materials which are impossible to machine without tearing.

The high speeds of which thread-rolling machines are capable make it incomparably faster than any other method suited to the production of similar designs when the material used is within the normal hardness range for rolling. Production rates for reciprocating flat-die machines

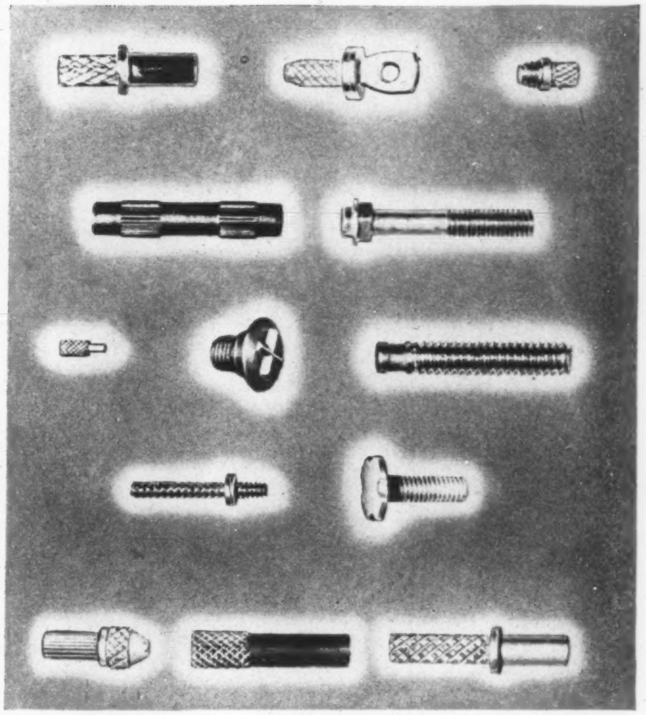


Fig. 3—Above—A group of small cold-headed parts finished on flat-die thread-rolling machines

Fig. 4—Below—Group of machine parts with grooves, short threads, multiple leads, and micrometer threads produced on cylindrical-die thread rollers

range from 30 pieces per minute with the larger machines to around 175 pieces per minute with the small automatic machines. As a rule, parts over 0.625-inch diameter are hand-fed and normally output is limited to about 60 pieces per minute, although in cases where maximum precision is required the top rate is usually about 30 pieces. Cylindrical-die machines in most cases are somewhat slower, production rates ranging from around 5 pieces per minute with the larger, hand-fed parts to around 40 pieces maximum with smaller parts and semiautomatic feeding devices. Where speed of production alone is essential and the qualities afforded by cold-working can be dispensed with, hot rolling can sometimes be employed to advantage with thread-rolling machines, the ease of working gained thereby allowing both greater diameter and more severe deformations than that indicated by the cold-working capacity of the machines used. The added cost of heating and somewhat inferior surface finish, however, as with hot upsetting must be offset by the advantages gained and requires careful evaluation.

Peak rolling surface speed for dies is around 314 surface feet per minute, at which point the peak load also occurs. Round dies, by virtue of constant speed of rotation, maintain the same speed of blank rotation as with flat dies while operating at about one-third less surface speed. Increased die life is considerable.

To be recognized and taken into consideration along with the advantages of quality, precision, versatility and

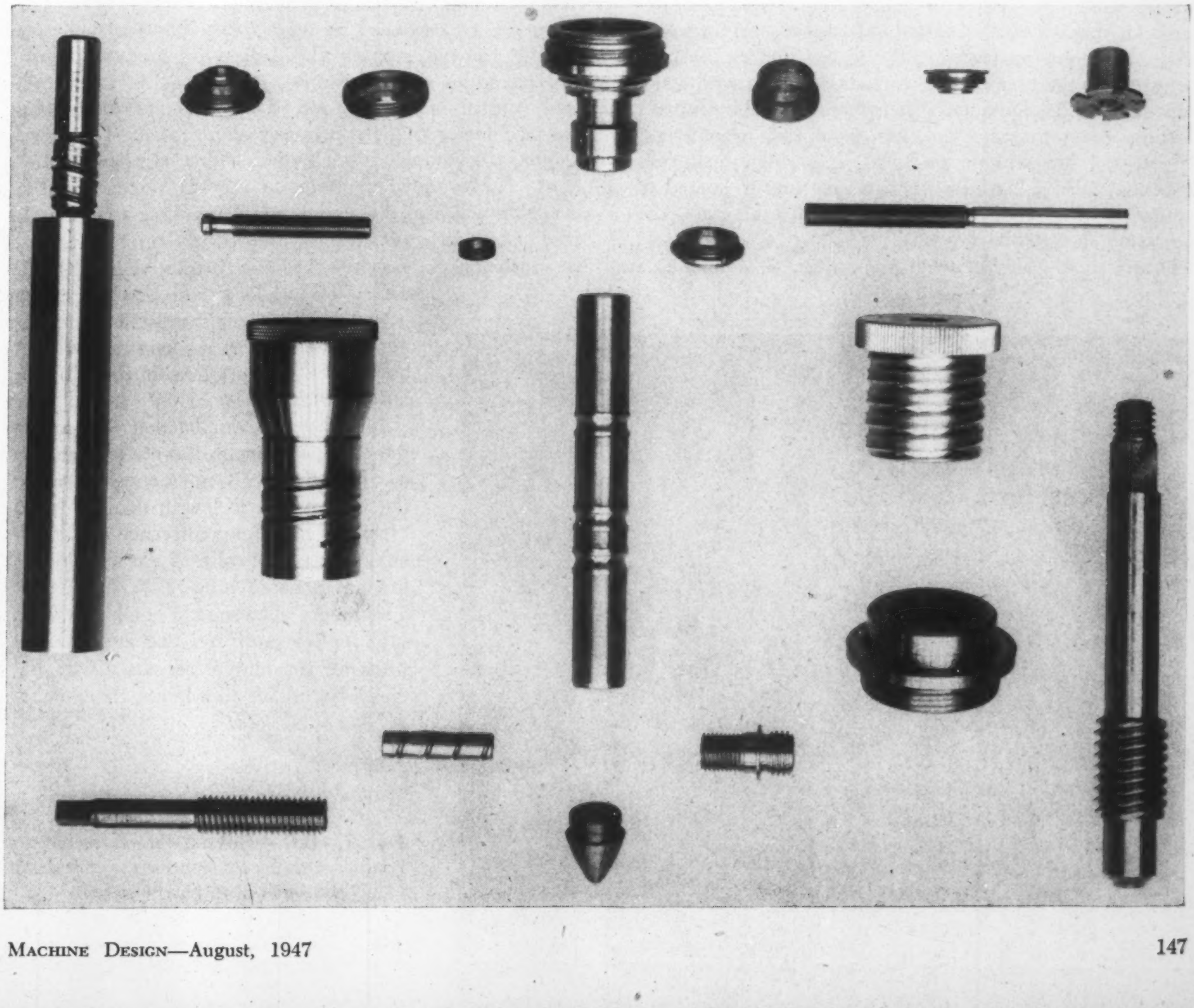
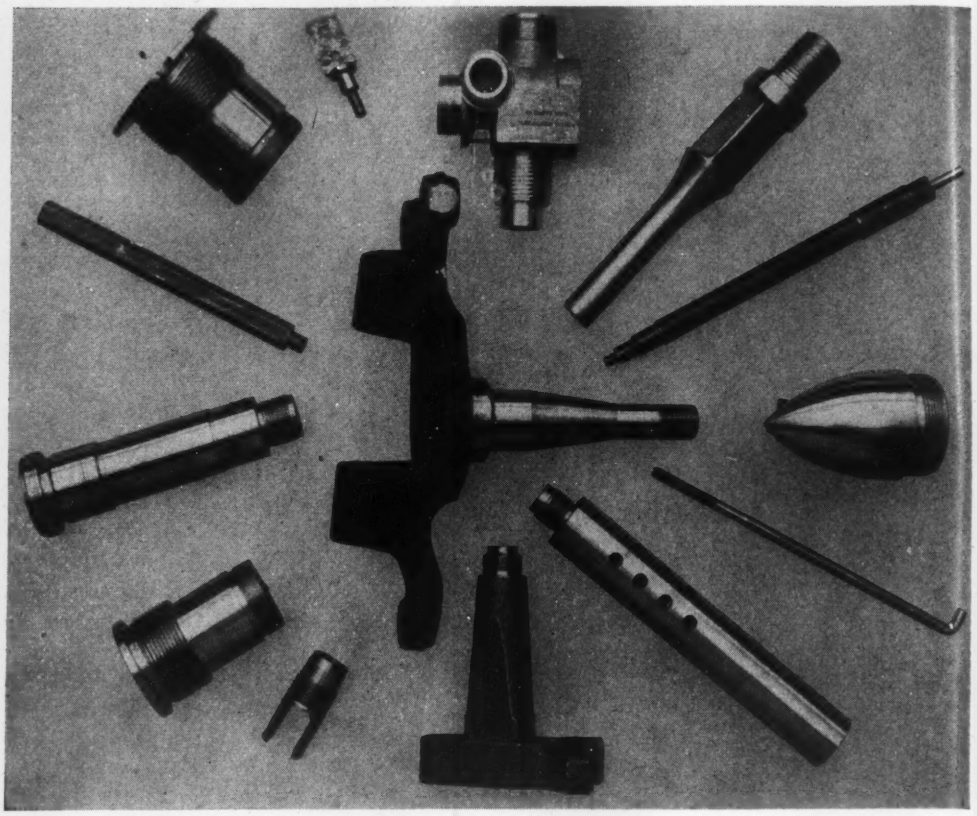


Fig. 5 — Right — A representative group of awkward machine parts the threads of which were rolled on a cylindrical-die machine



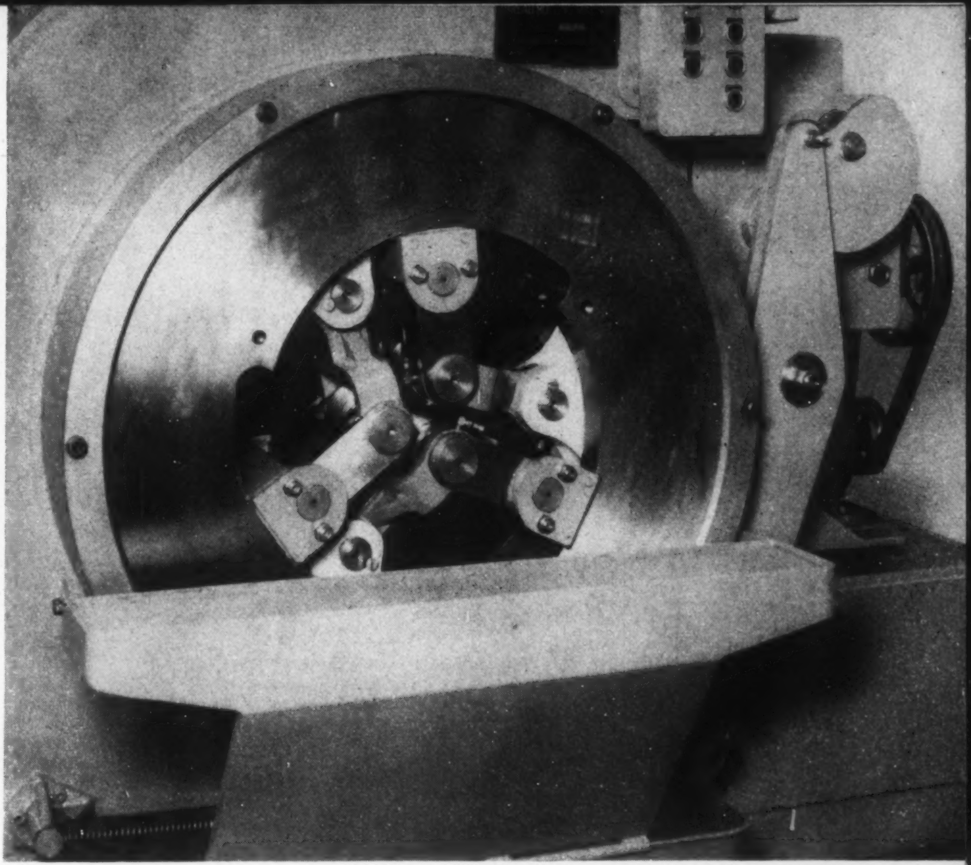
economy of thread rolling are a number of broad limitations which normally apply to this method of processing. First, the nature of the process itself makes it impossible to produce internal threads or forms. Only in the case of some special machines used for threading extremely thin-wall tubing can internal threads be produced. Being essentially a high-production process it is seldom practical for producing small quantities and in this aspect it parallels the cold-heading process. Because metal is displaced in producing a specific thread or form, finished part diameter is always greater than the blank, a characteristic which is objectionable where a shank and finished diameter must be the same. An extra turning or extruding operation, however, can often correct this feature but, of course, at extra expense in many cases. Coarse-pitch threads or forms on small diameters are often difficult to produce without distortion of the blank. Too, threads or forms with steep sides and wide flats such as square threads, buttress threads, acme threads, etc., are susceptible to material defects and are seldom produced when high quality is requisite. Lastly, hardness of materials used is limited to around rockwell C-35 to C-40 and beyond this point die life is too short to be practical.

DESIGN: As can be noted from *Figs.* 3, 4 and 5, a wide variety of machine parts can be designed to utilize thread rolling. An almost unlimited variety of thread forms can be produced on solid and hollow parts, special annular bearing grooves and helical oil grooves, knurls and serrations of any variety, single, double and triple lead worms, burnishing, etc. Diameters are limited by the machine capacities previously enumerated. The rolled length, too, should normally fall within machine limitations. However, where forms or threads longer than the available width of dies are required, rerolling can be utilized. Continuity of such forms produced in two passes, for instance, is accomplished by overlapping, *Fig.* 8. Actual overall length of parts having a portion of their length rolled is relatively unrestricted—parts as long as 20 feet have been produced with threaded or formed ends.

Limiting the application of rolling threads and forms in flat-die machines is the fact that it is impractical to make flat dies greater in length than 10 to 15 times the blank circumference and available die cavity length of the machines is limited as noted previously. Ordinarily, a minimum allowance of one-half a work turn for leave-off and one and one-half turns for finishing is necessary with flat dies. Naturally, this limits the number

Fig. 6 — Left — Flat-die thread roller arranged with a cold header for automatic production of machine bolts

Fig. 7—Right—A large Reed A31 horizontal rolling machine capable of handling diameters up to 6 inches



of turns available for penetration—the rate at which the form on the dies is impressed into the blank. Dies usually must be of sufficient length to allow a minimum of four work turns of a blank and, for accurate rolling in the harder materials, a minimum of seven work turns is recommended. Length of rolled portion should not be less than one diameter to avoid the tendency of short lengths to skew in the dies.

Average penetration per contact of a given point on a blank with the die surface cannot be less than: Thread depth ÷ (Total die length ÷ pitch circle circumference). Considering a ½—13 thread rolled between two dies the total length of which is 15 inches, average penetration per contact on the blank is 0.0047-inch. While this rate is not excessive for solid blanks, it would collapse or distort hollow ones, where penetrations of 0.001-inch and less per contact often are necessary. In such cases cylindrical-die machines are employed and the number of work turns can be varied as desired to control penetration rates accurately. Too, parts shorter than one diameter in length can be readily handled in these machines because of three-point support and the possibilities of outboard steady rests.

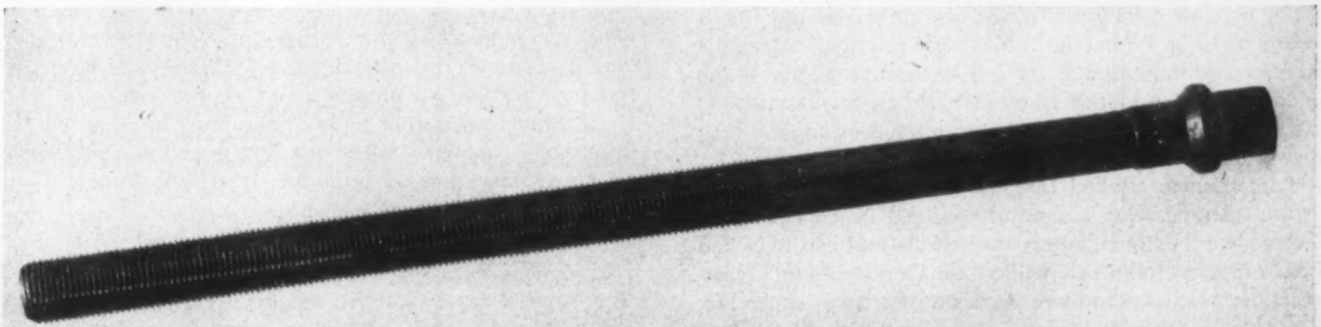
Blanks Must Be Accurate

Blank specifications are of great importance in producing accurate rolled work. Blanks must be round to start with, inasmuch as in only a few cases of noncircularity will any of the various machines correct out-of-roundness. Blanks for rolling are always smaller than the finished part, usually being within a very few thousandths of the pitch diameter of the form, *Fig.* 9. The volume of metal upset above the blank always approximates the material displaced in rolling but because material, hardness, finish, etc., affect the final result, the exact diameter should be established by trial. Hollow blanks may be affected by wall thickness, use of support arbors, and rate of penetration as well. The same is true of extremely thin-wall blanks mentioned in the foregoing; shell diameter will be just slightly larger than the pitch diameter but must be established by trial for accuracy.

Blank diameters should not vary along their length to assure maximum uniformity of the finished part. Ends of blanks should be beveled to a 60-degree included angle to the root diameter of the form to assure maximum die life inasmuch as this tends to minimize severe bending action on the rolling blanks. Necks adjacent to shoulders are unnecessary and sometimes detrimental to good rolling but where such are necessary for design purposes, 60-degree included angles should be used as indicated in *Fig.* 10.

Tolerances on blank diameter usually should be approximately two-thirds that on the final rolled diameter of the part. Where blanks can be made directly from commercial rod stock without further finishing, maximum

Fig. 8—Below—Produced on a special reheader, the blank for this part was threaded in a special flat-die machine. The ¾—14 thread is 9 inches long



economy can be realized. However, where accuracy such as that of Class 4 or 5 threads is desired, for example, the blanks must be centerless ground to within a total tolerance of 0.0005-inch. Considering Class 3 threads as an example, screw machine produced blanks should be held to a total variation of 0.001 to 0.002-inch.

Materials: Normally any of the materials ordinarily used can be rolled, including steels with hardnesses ranging up to rockwell C-35. Brass, bronze, nickel, nickel steel, Monel, Everdur, aluminum, silver, stainless, tool steels, high-speed steels, die-cast white metal, fiber, etc., have been handled. Though ductile, low-carbon cold-forging materials with hardnesses up to rockwell C-32 are most commonly and most easily rolled, it is possible to roll materials as hard as rockwell C-35 to 40, though of course die life is progressively lower as hardness increases. For best results with forms which require a considerable amount of metal movement in rolling or where the material is in the upper rolling hardness range, free-machining elements such as silicon, phosphorus, lead and sulphur should not be present. Elements which make for ease in machining are detrimental to good cold-forging characteristics in metals and as with cold heading (see Part XIII of this series) a compromise must be made by the designer in selecting materials depending primarily upon the combination of processing methods necessary to produce a specific part.

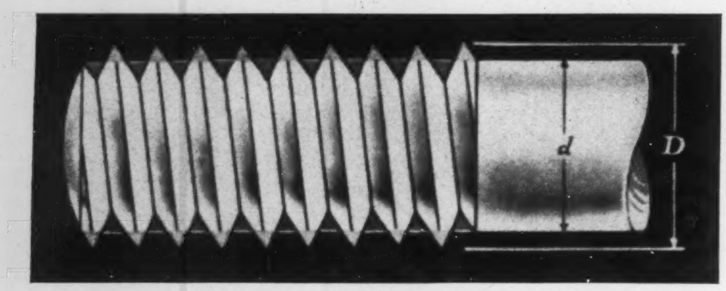


Fig. 9—Above—View of a rolled thread showing blank to finished diameter relationship characteristic with rolling

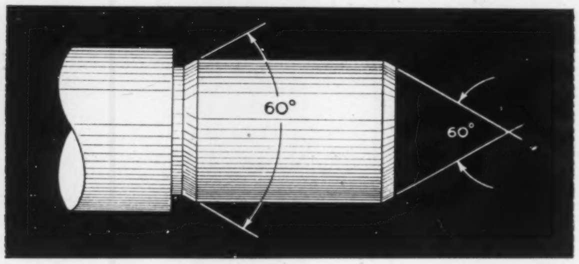
Roots Harden to Greatest Extent

When rolling threads in heat-treated blanks, the root of the form work-hardens to a greater extent than the crests. With rockwell C-34 blanks, the roots reach a hardness of nearly C-60. Inasmuch as this is approximately the hardness of the dies, it can be readily seen that unless extremely low penetration rates are employed die life is so low as to be impractical. Naturally production speed is sacrificed where such parts are necessary, although the quality of the product is often such as to warrant the extra cost, aircraft fasteners being a good example where this is the case.

Tolerances: Rolled threads provide an excellent key to the tolerances available and practical in rolling. Class 2 threads are extremely easy to produce and can be rolled from ordinary rod stock without further finishing. However, inasmuch as the more accurate dies have longer life, dies thread-ground to Class 3 specifications will produce Class 3 threads at a cost below that for Class 2 with inferior dies. By holding the thread depth on the dies and the blank to proper tolerances, Class 4 threads can be produced.

Cylindrical-die thread rollers will produce Class 4 and 5 threads when desired. Pitch diameters in production often can be held to within a total variation of 0.001-inch while thread to shank concentricity can often be held to within a total variation of 0.0003-inch. Micrometer shafts, *Fig.* 4, have been rolled to plus or minus 0.0001-inch on diameter with a lead accuracy of 0.0001-inch.

Fig. 10—Below—Where undercut necks must be used design shown should be employed for best results



Rolled forms and threads have greater uniformity and better surface finish, *Fig.* 11, than obtained with other methods. Comparatively speaking, surface finish of rolled threads is rated around 4 to 8 microinches while commercial finish on ground threads runs from 8 to 16 microinches, 60 to 65 microinches with milled threads, and 125 to 250 microinches with chased threads.

In specifying for rolling it must be remembered that rolling usually results in a lengthening of the workpiece to a certain extent. Although in most cases this effect is of no consequence, it may create out-of-limit parts where length tolerance is critical. Too, where parts such as those with rolled oil grooves or bearing grooves, the material thrown up during rolling often must be removed by means of a final centerless grinding operation and finish tolerances may depend primarily upon this operation.

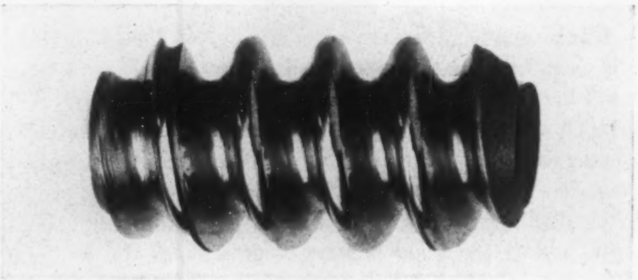


Fig. 11—This special form, rolled in SAE 1020 steel, indicates the extremely high quality surface finish obtainable

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Allied Products Corp. (*Fig.* 8)	Detroit
Chrysler Corp. (*Fig.* 6)	Detroit
The National Acme Co.	Cleveland
Reed Rolled Thread Die Co. (*Figs.* 1, 2, 4, 5, 7, 9 and 10)	Worcester, Mass.
Lamson & Sessions Co. (*Fig.* 3)	Cleveland

Molded Plastics Standards

. . . for materials specification and design practice result in superior plastics parts

By John Delmonte
Technical Director
Plastics Industries Technical Institute
Los Angeles

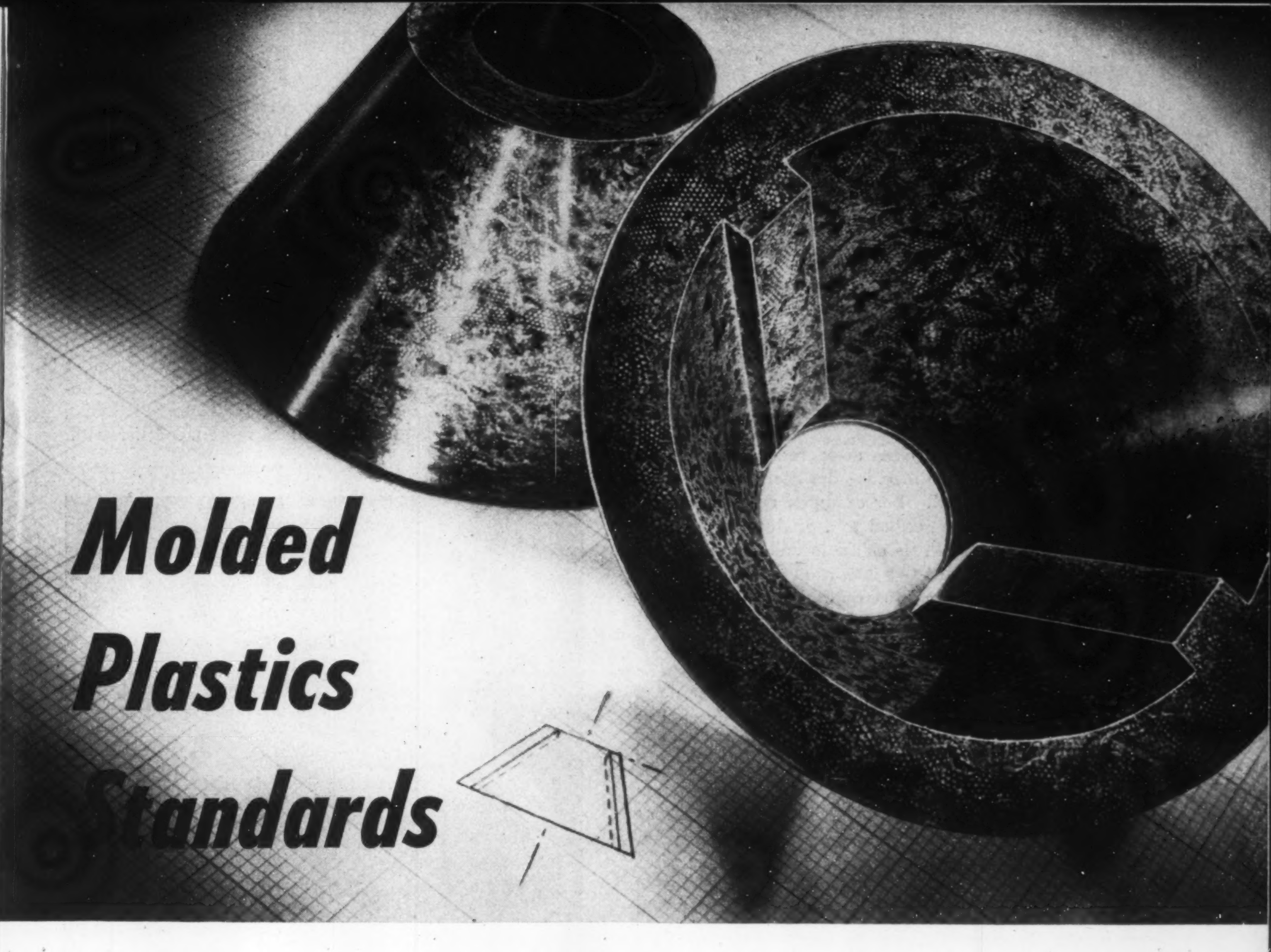


Fig. 1—Above—High impact strength phenolic, rag filled, is utilized in molded clutch cone

MOLDED plastics materials have at long last come of age. Standard specifications now define not only their properties but also their design limitations. Need for information of this nature has long been felt by engineers responsible for the applications of plastics to various machines and products. Because of the varied chemical nature of the materials and the differences in properties, standardization has not been easily achieved. Many individuals interested in the production as well as the end uses of plastics, have co-operated in preparing specifications. These initial efforts have been made at a most timely phase of the plastics industry development. Today, industry leaders in a realistic self-appraisal are making every effort to discourage poor applications of plastics. The success of these measures depends in part upon consumer education which informs potential users of the best design practices, so that when specifications are drawn or requirements stated, they will reflect cognizance of standardized practices.

Standardized design practices not only assist molders, fabricators and laminators in preparing their tools and in framing intelligent quotations upon a job, but also save considerable engineering design time on the part of the consumer by clearly defining, for example, correct tolerances for plastics parts. Of course, the type of tooling and the production methods to be employed will also in-

TABLE I

Typical Characteristics of Phenolic Molded Parts

Type No.	Description of Material	Impact Strength (Izod) (ft-lb/in. notch, min)	Tensile Strength (psi, min)
1	Unfilled, transparent phenolic	0.36	7000
2	General-purpose, wood-flour filled ..	0.24	7000
3	General-purpose, wood-flour or cotton-flock filled	0.34	7000
4	Moderate impact strength, rag filled .	0.80	5500
5	Medium impact strength, rag filled .	1.75	6000
6	High impact strength, rag filled	4.00	6000
7	Low electrical loss, mineral filler ...	0.30	5500
8	Superior electrical, high frequency ..	0.30	5500
9	General-purpose mineral filled for mechanical and electrical	0.70	4500
10	Heat resistant, mineral filled	0.25	5000

fluence design, though by close co-operation between the plastics fabricator and the machine designer, a satisfactory solution can be obtained. For example, before a design in molded plastics is transcribed to a production drawing, the custom molder should be called in and the part carefully studied. Usually the two interested parties are called together when preliminary price quotations are requested.

It is significant that much time has been spent by materials manufacturers, fabricators, and consumers during the past few years trying to arrive at a set of standard specifications for plastics materials, analogous in some respects to the SAE numbers for steel, where the numbers reflect certain qualities of the plastics. The problems are even more difficult for plastics because of their varied chemical nature. It would be like trying to establish a common code of numbers not only for steel, but also inclusive of lead, copper, aluminum, etc., and their alloys. However, the steps have been undertaken under the auspices of the Society of the Plastics Industry, and while code numbers for various molded plastics are far from universal acceptance as yet, the number of organizations adopting the SPI numbers for molded plastics materials is growing. It is the general feeling among most plastics engineers that the chemical identity of the plastic, coupled with the SPI number, will answer most requirements.

The SPI number is predicated upon the following physical factors:

1. HEAT DISTORTION TEMPERATURE which establishes the first two digits: 10 for 100 F, 11 for 110 F, 25 for 250 F
2. MINIMUM IMPACT STRENGTH which determines the next two digits: 03 for 0.3 ft-lb, 15 for 1.5 ft-lb, etc.,
3. TENSILE STRENGTH which sets the fifth and last digit: 5 for 5000 psi, 7 for 7000 psi, etc.

Thus, for example, the molding compound SPI 24046 would have a heat distortion temperature of 240 F, an impact strength of 0.4 ft-lb per inch of notch, and a tensile strength of 6000 psi. The material would probably be thermosetting as the great majority of thermoplastic molding compounds have heat distortion points under 200 F. However, this method of specification teaches the designer to indicate the property values best suited for an application, leaving the choice of material to the molder. Factors such as cost, chemical and electrical properties, color, moldability and many other items do not appear in the above classification number. While the system is far from fool-proof, when mentioned in connection with the chemical identity of the plastic, the SPI code number proves useful. Quite a few code numbers have been tabulated by the SPI, ranging from SPI 10232 to SPI 30026, though the complete list will not be reproduced herewith.

TABLE II

Typical Characteristics of Melamine and Urea Plastics

	Type Number and Description	Impact Strength (Izod) (ft-lb/in., notch min)	Flexural Strength (psi, min)	Arc Resistance Time (seconds)
1	Melamine, alpha-cellulose ..	0.2	9,000	80
2	Melamine, mineral-filler	0.25	7,500	120
3	Melamine, chopped-rag filler	0.55	10,500	120
4	Melamine, phenol-formaldehyde (85:15) rag filler ...	0.9	13,000	8
1	Urea. general-purpose alpha-cellulose filler	0.20	10.000	...
2	Urea, general-purpose cellulosic fillers	0.20	10,000	...
3	Urea. arc resistant cellulose filler	0.20	10,000	90

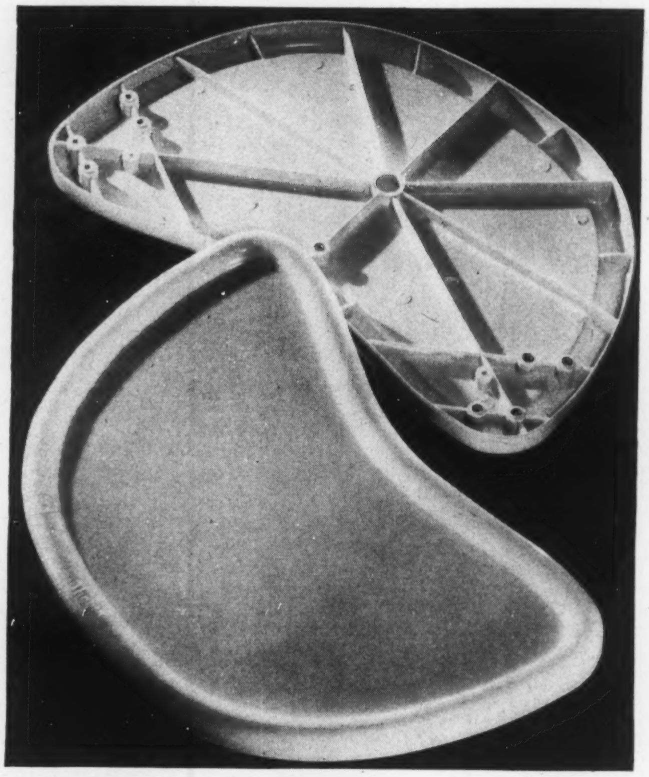


Fig. 2—Inserts in underside of tray facilitate fastening. Tray is molded cellulose acetate butyrate with ribs for reinforcement

It should also be noted that all of these physical properties are determined by the standard testing methods of the American Society for Testing Materials.

Among other material standards which should be observed are those issued by the ASTM which define the properties of various plastics. These specifications represent a departure from earlier practices which were confined primarily to definitions of the testing procedure. Because phenolics are widely employed by machine designers, their properties are listed in TABLE I (from ASTM D-700-43T).

It should be noted that the values in TABLE I are minimum and that heat distortion points, which are not listed in this ASTM specification, are from 250 to 300 F for most of the materials. High impact strength materials such as ASTM Type 6 have important machine applications, *Fig.* 1. Urea and melamine formaldehyde, as well as cellulosic plastics are listed similarly though the number of standard plastics types are less. For example, ASTM D-704-44T indicates four standard melamine formaldehyde molding compounds. Some of their characteristics are shown in TABLE II, together with three standard grades of urea-formaldehyde plastics, which are described in ASTM D-705-43T.

As in TABLE I, the values shown in TABLE II represent minimum values. The arc resistance rating (ASTM D-495-42) were included because, in addition to the prominent roles assumed by urea and melamine formaldehyde plastics in furnishing colorful plastics, these materials are outstanding in electrical properties, particularly with respect to resistance to arcing. Similar specifications have also been adopted for laminated plastics, with three main types: Cellulose paper, cellulosic fabric, and asbestos base. These are subdivided into twelve standard grades (using the same letters standardized by the National Electrical Manufacturers Association—Type X, C, A, etc.).

Similarly the ASTM has established property standards for polystyrene, cellulose acetate, cellulose acetate-butyrate, polyvinyl chloride-acetate, ethylcellulose, nylon, and polymethyl methacrylate molding compounds. These are thermoplastic types of material and, while their significant properties are much too extensive to reproduce herewith, the ASTM standards relating to them are:

Polystyrene Molding Materials	ASTM D-703
Cellulose Acetate Molding Materials	ASTM D-706
Cellulose Acetate-Butyrate Molding Materials	ASTM D-707
Polyvinyl Chloride Acetate Molding Materials	ASTM D-728
Polyvinylidene Chloride Molding Materials	ASTM D-729
Ethycellulose Molding Materials	ASTM D-787
Nylon Molding Compounds	ASTM D-789
Methyl Methacrylate Molding Compounds	ASTM D-788

It is recommended, when the machine designer consults

TABLE III—Recommended Design Practices

Design Factors	Correct Practice
SHRINKAGE: Shrinkage between mold dimensions and molded piece is extremely complex, particularly as the shape of the piece becomes involved. Shrinkage is greater parallel to flow direction than across flow direction. Nonuniform thickness in molded parts produces an unbalanced shrinkage and subsequent warpage. Surface shrink marks develop on thick sections of thermoplastics	Abrupt changes in wall thickness should be avoided, and as uniform a section as possible maintained Control of shrinkage requires careful mold design procedures, which control direction of material flow and make allowances for thermal differences between plastic and mold material Higher molding pressures and preheating of material reduces the shrinkage slightly Flat sections are preferably backed up with reinforcing ribs Size of gates in injection and compression molds should be large enough to maintain good pressure Parts may be cooled in shrink fixtures, and cooled slowly to reduce residual stresses
RADII AND FILLETS: Stress concentration factors of plastics tend to be high and flow marks to be pronounced in the presence of abrupt radii and fillets	Well rounded corners should be employed on both inside and outside radii (See TABLE IV for recommendations) Reducing stress concentrations by proper designing will increase working stresses of plastic
UNDERCUTS: Undercuts in molded parts require split mold sections or removable mold parts, raising piece costs	Undercuts should be avoided unless necessary to design, then discussed with molder to ascertain limitations of his tools When shallow undercuts are required stripping from mold part when hot has been possible Design may utilize two or more pieces to be cemented
THREADS: Molded threads or drilled and tapped threads in molded parts are not as strong as metal counterparts	If threads are to be small, metal inserts are recommended. If threaded assemblies are to be made with aid of wrench metal threaded insert is preferred External threads should start at least 1/32-in. from end and not run to face of molded body Well rounded threads for bottle closures may in some cases be stripped from mold without twisting
DRAFT: Molded parts require adequate draft or taper to remove from molding surfaces	Draft of ½ to 2-degree taper covers most examples, though more and less are used In deep drawn parts converging tapers are recommended, creating a slight wedging action as mold is closed Highly polished mold surfaces aid removal of part from mold
RIBS: Ribs help to prevent warpage and aid in flow and distribution of molding material	Good fillet at base of ribs should be employed Width at base of rib is recommended as ½ wall thickness, to avoid sink marks in injection moldings
WALL THICKNESS: With wide variations in wall thickness, uneven cure and conditions for warping are augmented	Thermosetting materials are seldom less than 1/16-inch thick With proper preheating, thick molded thermosetting materials offer no problem Sink marks in thick thermoplastics are minimized by deeper gating and longer cycle time in machine. The maintainance of full positive pressure on material aids uniformity For reasons of economy, thick molded sections should be cored out if practicable, and uniform wall thickness maintained

such specifications, that properties such as the heat distortion temperature and impact strength (which determine the SPI numerical classification) be noted. The heat distortion points are listed in the specifications for thermoplastic molding materials, and determine practical operating temperature limits. The data contained in these specifications, coupled with good engineering will help insure sound applications of plastics which should give trouble-free service.

Recent efforts at standardization of molded plastics parts have established significant design practices, which are discussed in some detail in a booklet issued by the SPI (Advance Chapter No. 6—"Design of Molded Articles" SPI-Nov. 1946). The problems do not resolve themselves into a series of simple formulas which determine correct design. Variables in molding materials, atmospheric conditions and molding techniques have much to do with the quality and tolerances on the final molded articles. Only recently manufacturers of molding compounds have made co-ordinated efforts to establish standard testing procedures and standard molds for evaluating the performance of molding compounds and for exploring the effects of moisture, pressure and temperature. That this work is now under way is evidence of the recognition of the need for standard molding practices.

In Table III some of the better design practices are listed.

Tolerances on Molded Plastics Parts

Dimensional tolerances in molded plastics parts have been the subject of careful study, and values to be incorporated in the design must make adequate allowance for molding techniques employed as well as for dimensional stability of the parts in service. SPI has made an initial survey of molding dimensional tolerances and has presented tolerances in three classifications: (1) Fine tolerance—very close limits, possible through strictest supervision. (2) Standard tolerance—usual tolerance which can be held under usual production conditions. (3) Coarse tolerance—permitting considerable latitude in dimensioning.

It should be noted, of course, that the closer the specified tolerance, the higher will be the cost of tools as well as the finished part. In general, higher pressures and transfer, plunger, or injection molding will permit closer tolerances than are possible by standard compression methods. These closer tolerances apply to those dimensions measured across parting lines or parallel to direction of mold closing.

In general, closer molding tolerances are held by molders in the United States than in England or European countries. To give a general picture of the range of molding tolerances recommended by SPI[*] Table V lists tolerances for certain selected dimensions. These tolerances are standard practice, with coarser limits preferred if very close accuracy is not required. In specifying tolerances for molded parts, the machine designer should try to take advantage of the inherent flexibility in many molded plastics (due to their comparatively low modulus of elasticity as compared to metals). This means that the molded parts lend themselves to "springing" into place during assembly, not necessitating a precision fit as may be required of metal stampings or castings.

Table IV

Stress-Concentration Factors at Corners of Molded Parts

Factor[*]	Ratio of Inside Radius to Wall Thickness
3.0	.1
2.0	.25
1.5	.60
1.3	1.0

[*] Proportional increase in estimated working stress.

Space does not permit a complete evaluation of the design standards which have been established for metal inserts to be used in molded plastics. Inserts are frequently produced on automatic screw machines and aid in the assembly of molded plastics parts, as well as in the attachment of electrical connections. These inserts may be brass or aluminum, and either threaded, (internally or externally) or anchored with some eyeletting device, *Fig.* 2. There appears to be a growing interest in aluminum-alloy inserts which have thermal coefficients more closely matching those of plastics than do brass inserts. Once again the designer will save both time and costs by employing insert design which has been standardized by molders.

Standard design practices are not a panacea for molded plastics. They will, however, aid the designer in achieving satisfactory applications of plastics materials. The standards are not absolute rules which must be followed, but rather are stepping stones from which improved designs in molded plastics will be developed.

Table V Standard Tolerances

(Plus or minus tolerances)

Type of Material	Method of Molding	Tolerance on One Tool Part for Diameters of			Tolerance on Linear Dimension[*] for Cavity depth of		Draft Angle (degree)
		1 in.	3 in.	5 in.	1 inch	3 inches	
General-purpose phenolic	Compression	.0045	.0072	010	.008	.012	¼
High-impact phenolic	Compression	.0055	.008	.011	.010	.014	¼
Alpha-cellulose filled urea	Compression	.007	.011	.015	.010	. . .	½
Polystyrene	Injection	.0037	.005	.0065	.004	.007	1
Cellulose acetate butyrate	Injection	.004	.0055	.0072	.005	.009	¼
Cellulose acetate (Medium flow)	Injection	.0038	.0055	.0072	.005	.009	½

[*] Dimension parallel to direction of mold closing.

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[*] Complete data on molding tolerances may be obtained from SPI, 295 Madison Avenue, New York 17, N. Y.

Wichita City Library

Planning Ahead in Design

Major emphasis has rightly been placed, since the end of the war, on high production of capital and consumer goods. Manufacturers who could go into production of prewar models with relatively few design changes were in an enviable position to meet the demand and to reap the benefit from their prewar engineering programs.

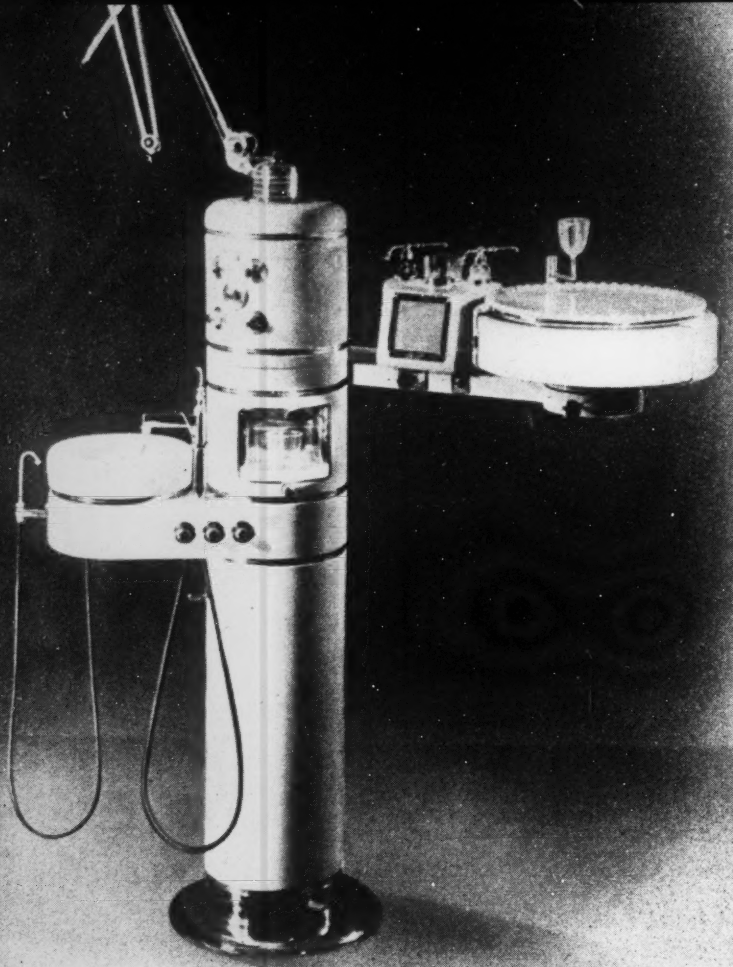
This picture now is changing rapidly insofar as the designer is concerned. Factors other than high production necessarily have to be taken into account in view of the more competitive days that lie ahead. Machinery companies that have not already done so are making market studies and laying plans accordingly. Many concerns that have been content to continue production of refined models are branching out into the development of entirely new designs, and other companies are diversifying their lines by adding entirely different machines to the types previously produced.

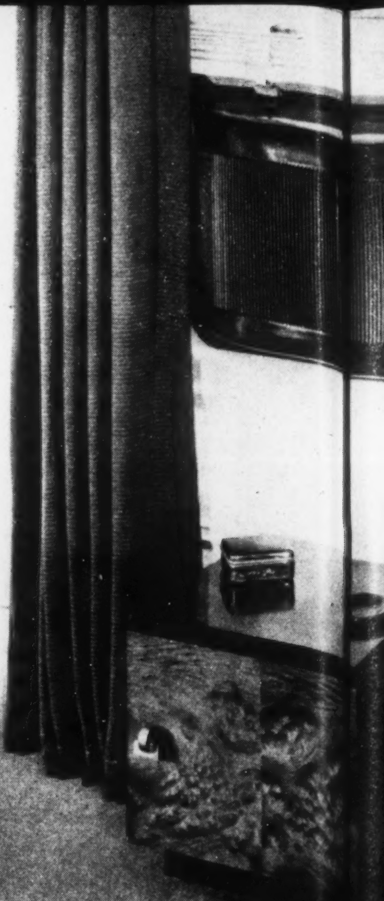
It has been proved repeatedly that the companies which are in the best position to make headway against all competition are those which have been sufficiently farsighted as to have alternative or modified designs laid out so far in advance that all forseeable contingencies can be met. Some of these manufacturers advisedly make a practice not only of having redesigned models ready to go into production when the time is ripe, but also of having still more advanced designs either completed or on the board. Automobile companies—to mention a specific classification—are not lacking in this respect. Even with the unsatisfiable demand for new cars at the present time, a new model Packard is now on display and Oldsmobile promises a radically new departure for next year. Undoubtedly these and other automobile companies already are developing later models.

Builders of machines of all other types might well emulate the methods of the automobile industry in the timeliness of announcing new designs. It probably would be safe to say that even if the nation were to be faced with a recession, the engineers of the automobile concerns would be ready to meet it with low-priced yet distinctive models on which the design work already has been completed.

Farsightedness in design pays big dividends. Machinery companies should encourage their engineers to utilize this characteristic to the fullest extent.

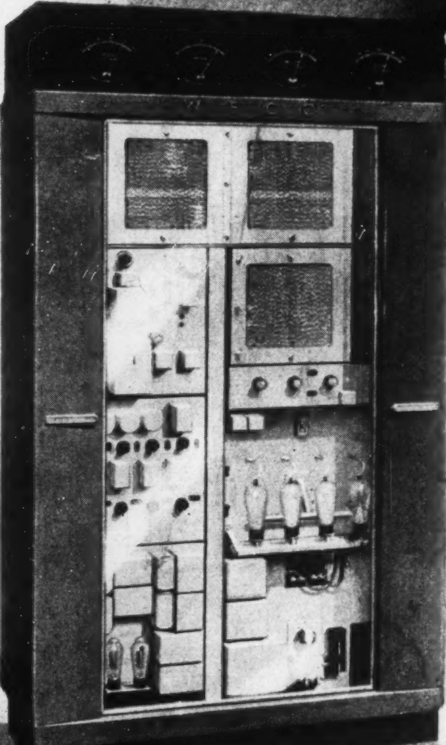
L. E. Jermy





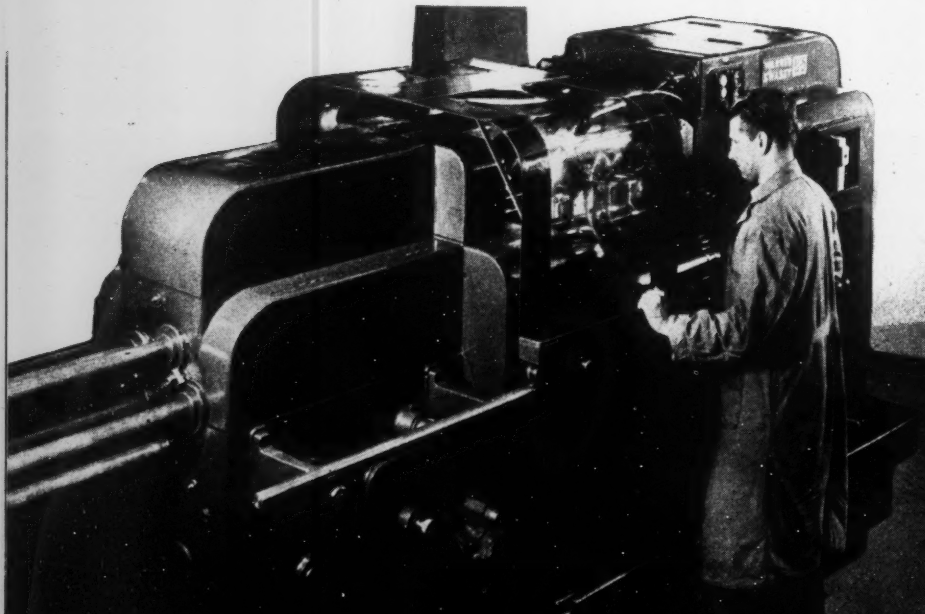
Right—Carrier window-mounted room cooler is styled to provide least clash with the different types of interiors in which units are to be installed. Designer: Henry Dreyfuss

Left—Supplanting conglomerate units of the past with their multiplicity of "Rube Goldbergish" arms and levers, this S. S. White column-type dental unit, styled by Henry Dreyfuss, presents a substantial, co-ordinated appearance, more convenient for the dentist and less forbidding to the patient



Below—Warner & Swasey automatic 5-spindle chucking lathe is designed for simplicity of form, sturdiness, safety, operator convenience and ease of maintenance. Designer: Henry Dreyfuss

Right—Apparatus of this frequency-modulation transmitter formerly was hidden by steel doors. Now Herculite glass paneling permits view of the orderly arranged components. Styled by Henry Dreyfuss for Bell Telephone Laboratories



Machines herein presented have been selected for their excellence of appearance. They serve to illustrate many

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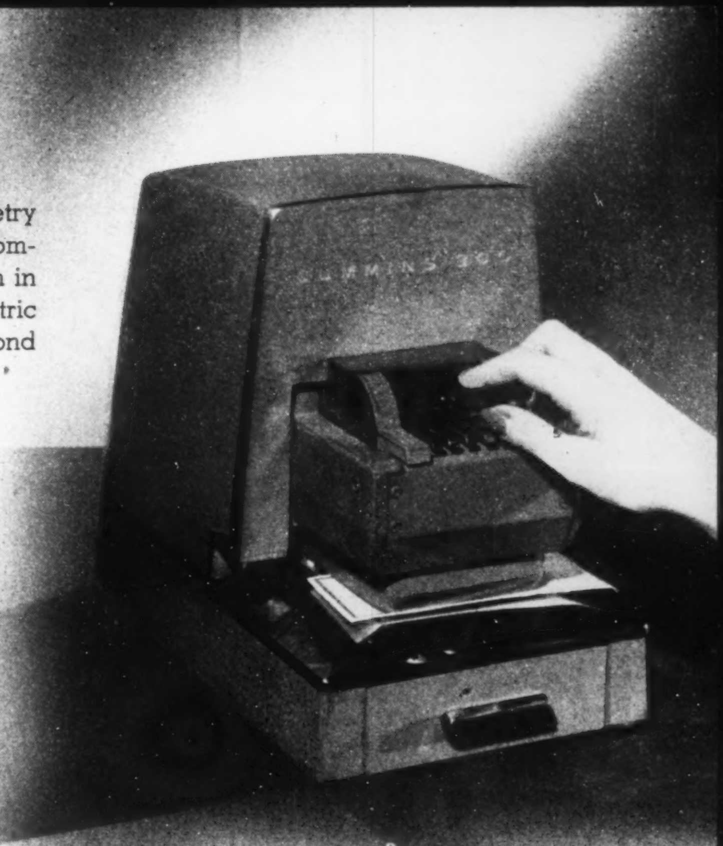
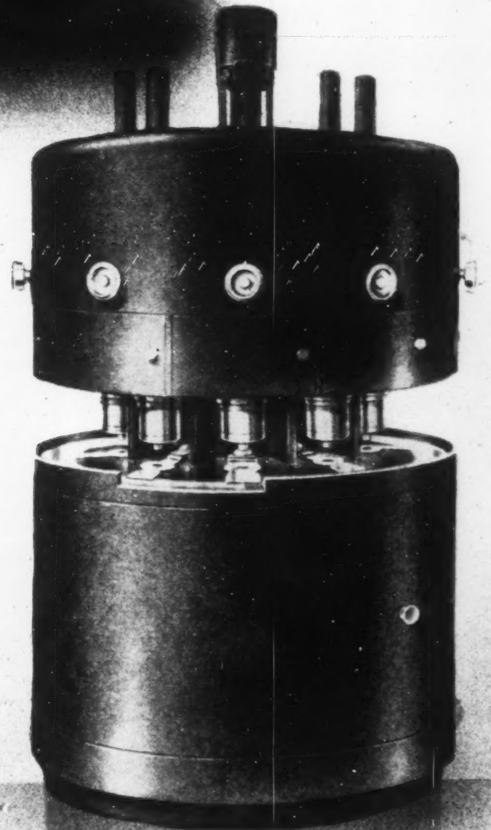


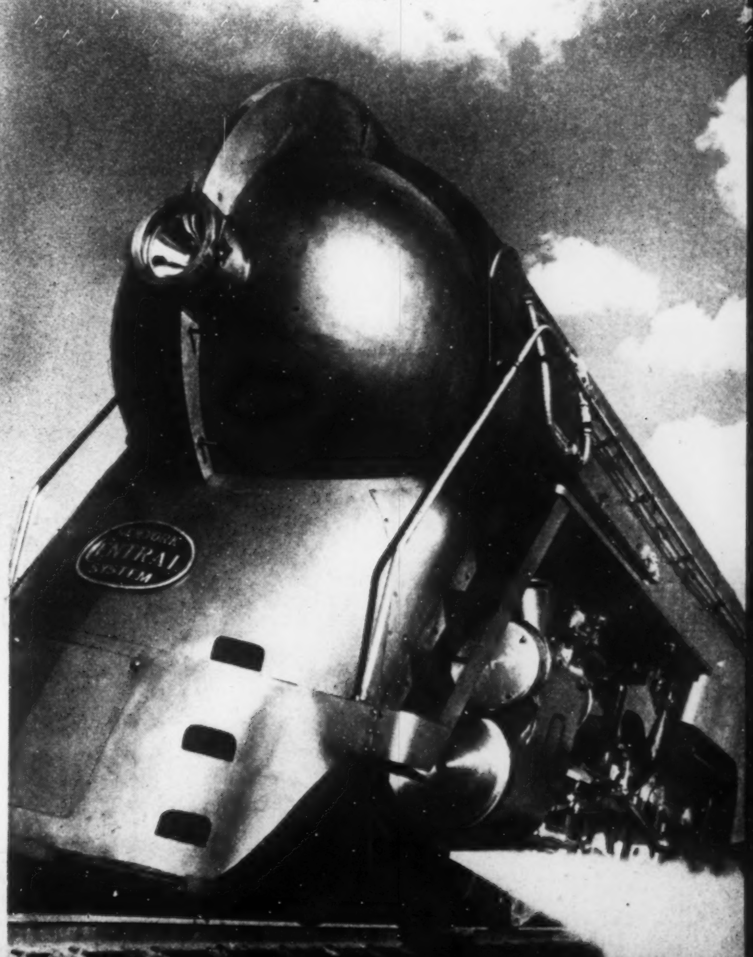
Right — Integrated symmetry and simplicity of form are combined with ease of operation in this Cummins portable electric perforator styled by Raymond Loewy Associates •

Below—Clean-cut, symmetrical appearance of this plastics molding machine implies excellence of engineering. All obtrusive parts have been modified and group-housing has been used effectively. Designed by Designers for Industry Inc. for Sorel Industries Ltd.

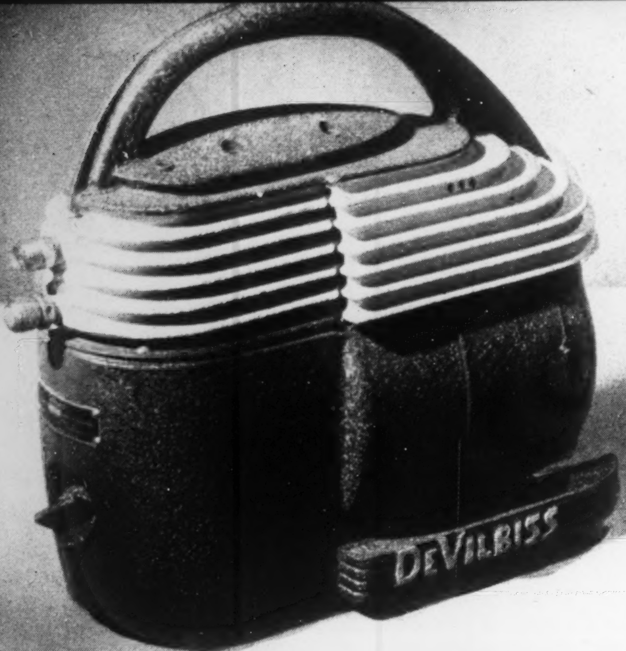


of the factors discussed by David F. Welch in his timely article "Design Trends", Page 109, this issue

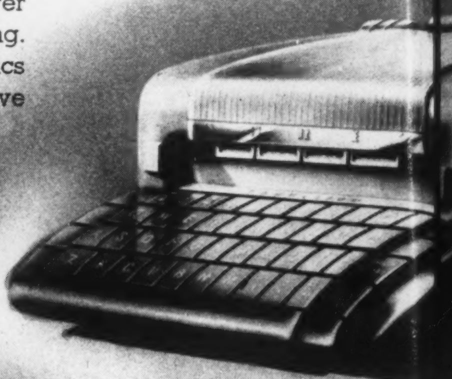
Below—Rugged reliability is suggested by this 20th Century Limited locomotive, exterior styling of which does not deter ready maintenance. Designer: Henry Dreyfuss •



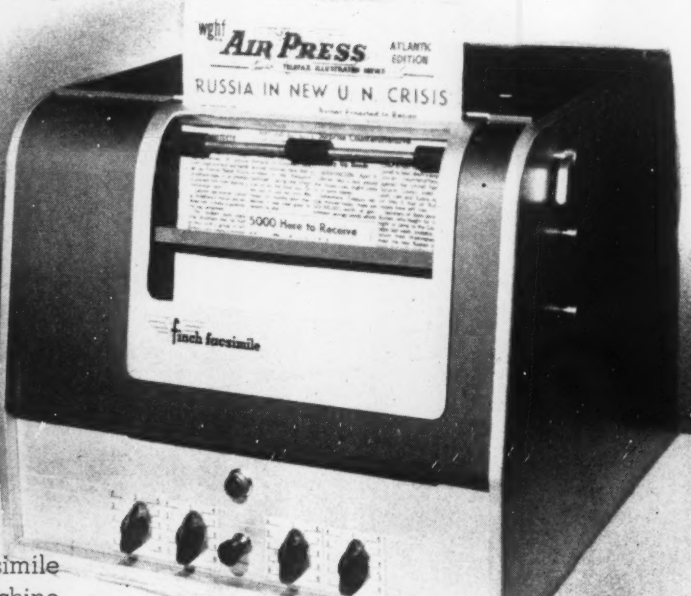
F THE MONTH



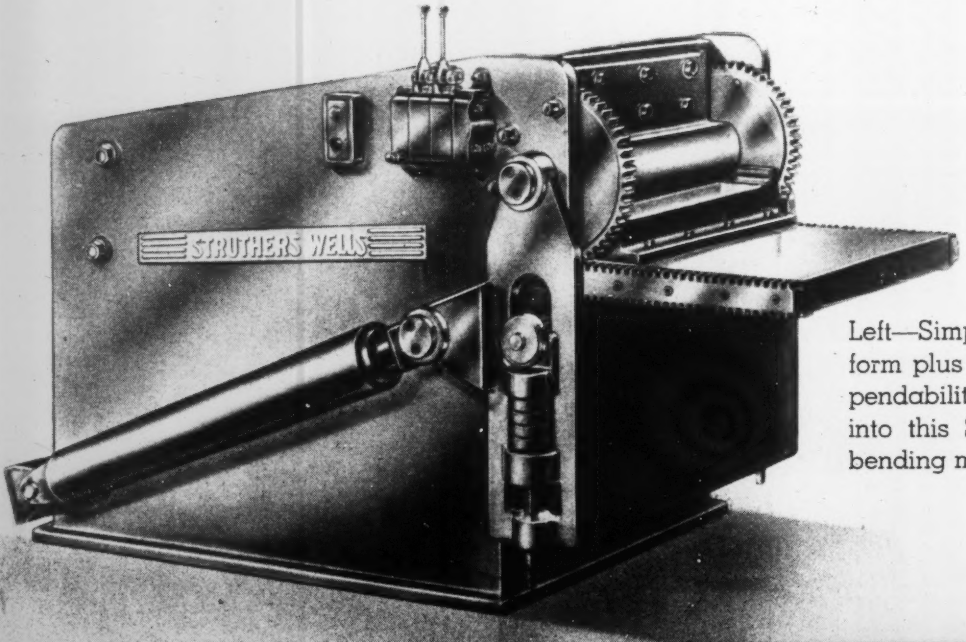
Right—What the typewriter of the future might look like. This plastics model envisages electrical operation of keys, dustproof housing over keys, and built-in lighting. Designed for Durez Plastics & Chemicals Co. by Dave Chapman



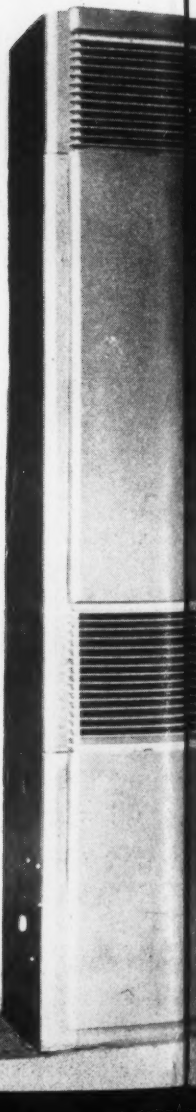
Above—Portable air compressor has cooling fins and handle cast integral to conform to airfoil shape of body. Finish is two-tone brown and orange wrinkle paint. Styled by Sundberg-Ferar for The Devilbiss Co.


wght AIR PRESS
ATLANTIC EDITION
RUSSIA IN NEW U N CRISIS
5000 Here to Receive
finch facsimile

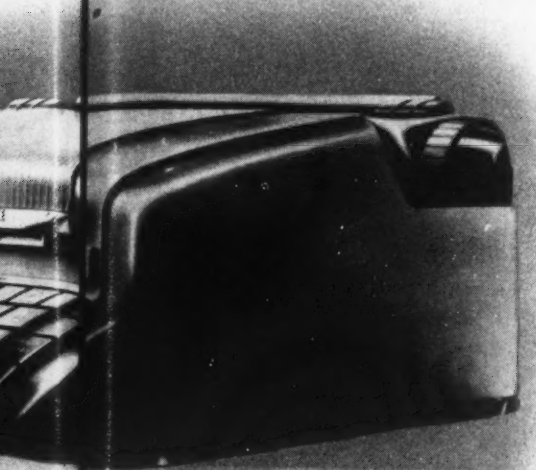
Right above — Finch Facsimile sending and receiving machine has combination cast aluminum and sheet metal housing. Trim cabinet was designed by Walter Dorwin Teague

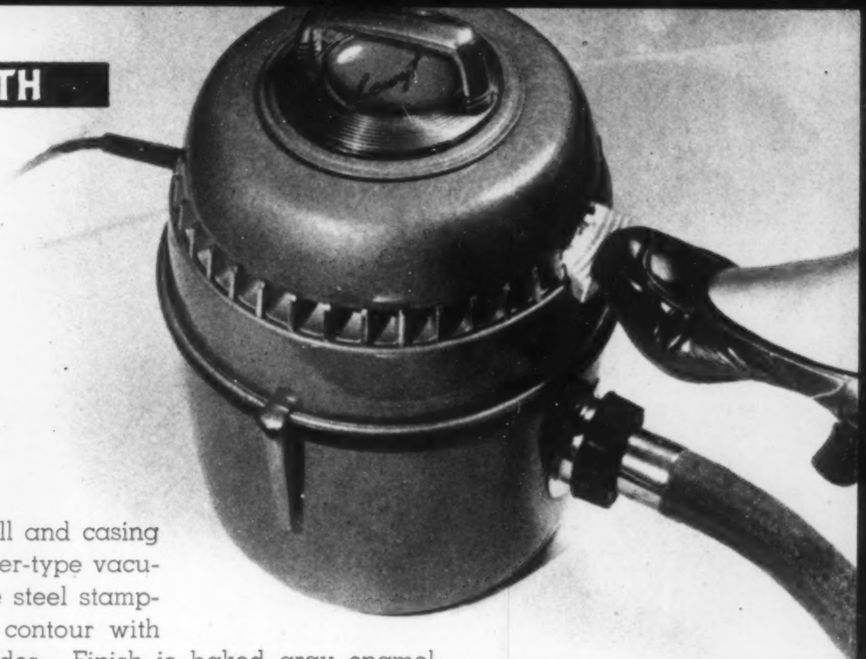

STRUTHERS WELLS

Left—Simplicity and symmetrical form plus an aspect of sturdy dependability have been designed into this Struthers Wells tangent bending machine by Designers for Industry Inc.

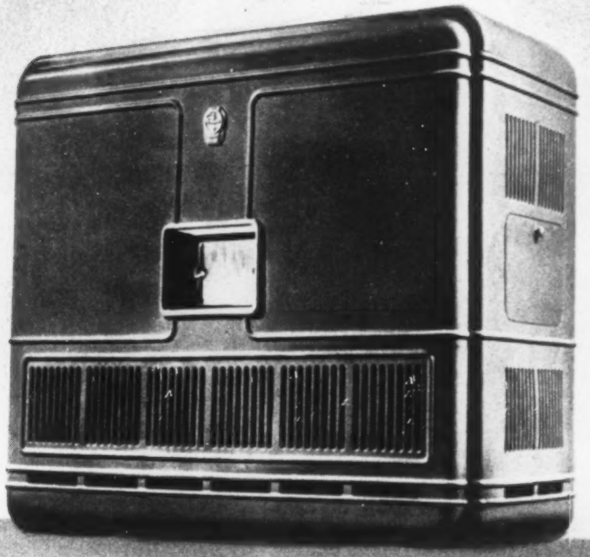


DESIGNS OF THE MONTH

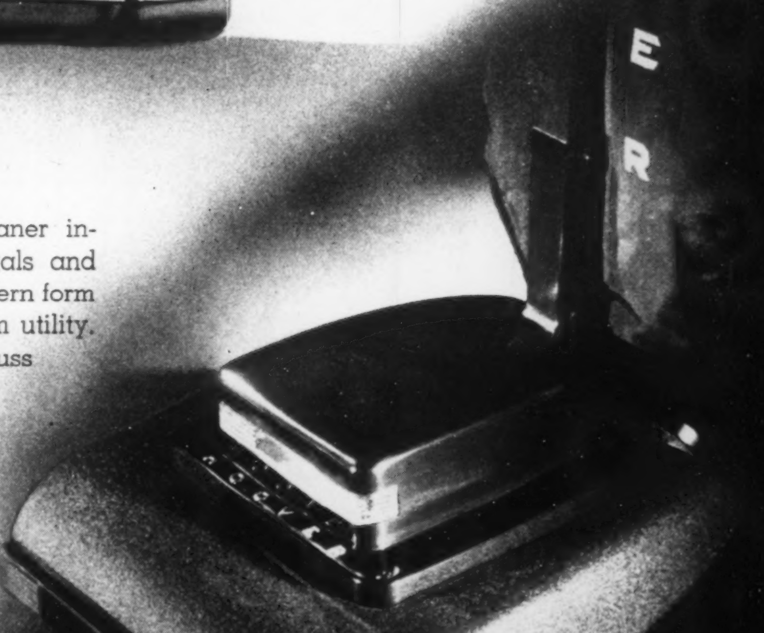




Right—Top shell and casing of Lewyt canister-type vacuum cleaner are steel stampings of barrel contour with bowed-taper sides. Finish is baked gray enamel, hammer tone, with aluminum and stainless steel trim. Designed by J. Gordon Lippincott & Co. Inc.



Left—Evans home heater, unlike some of its contemporaries, looks like a heater. Recessed flame-view window emphasizes the unit's function. Panels meet in harmonious radii, moldings being used to unite louver groups and fire door in integrated pattern. Finish is warm grayish brown. Designer: Walter Dorwin Teague

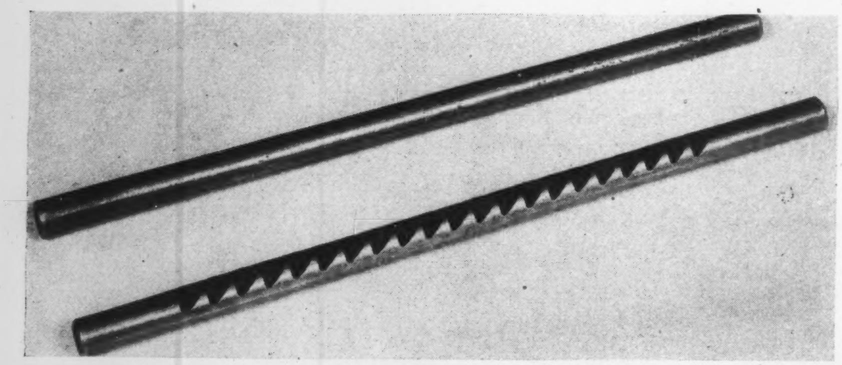


Right—Hoover vacuum cleaner incorporates light-weight metals and plastics in a clean-lined modern form free of frills and of maximum utility. Designer: Henry Dreyfuss

Left — Carrier self-contained air conditioning unit exemplifies excellent proportioning of louvers and panels. Designer: Henry Dreyfuss

Applications

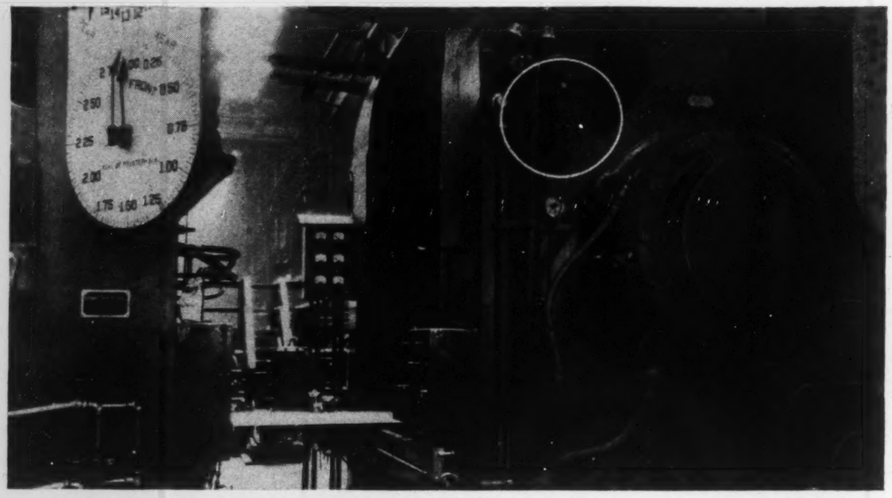
of engineering parts, materials and processes



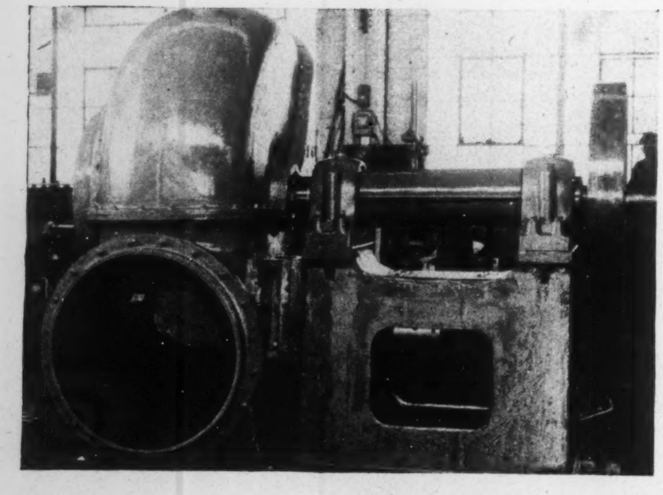
Brake Ratchet is Broached

RATCHET for automobile parking brake is broached from steel tubing in one stroke. All twenty notches for ratchet are formed simultaneously by multiple tool on six-ton Colonial Broach Co. press. Production of single machine has exceeded 175 ratchet units per hour.

Strain Gage Determines Pressure



STRAIN GAGE gives constant determination of pressure in rolling mill shown at left. In rolling practice, when pressures increase beyond a certain point they give no increased reduction in metal thickness but may cause equipment failure. The Pratt and Whitney gage mounted on the post of mill indicates optimum reduction point to operator, thus speeding rolling operation and eliminating danger to machine. Because strain gage employs an electrical circuit, as many indicating or signalling instruments as desired may be used at any remote location. Recording instruments may also be remotely located where desired. Reversing-type mills, for example, use meters at both control benches.



Fan Has Lead Casing

FAN, left, used for moving sulphuric acid vapor in chemical plants has lead casing, greatly reducing corrosion and lengthening life. Housing is sand cast of five per cent antimony lead by the United States Pipe and Foundry Co., using a special dry sand suited to the density of lead. Flanged cast-lead rings are bolted to the inlet and delivery openings and are welded to the sheet-lead ducts which convey the gases. Impellers are steel plate welded to the shaft and are covered with ¼-inch of lead bonded to the steel.

Cam Design Chart for Constant Acceleration

By E. A. Hartbauer
Design Engineer
F. B. Redington Co.
Chicago

ONE of the commonest forms of motion imparted by a cam is the so-called "gravity" motion. This motion is parabolic, the equation to the curve being

$$d = \tfrac{1}{2} a t^2$$

where a is the acceleration constant, d is the distance, and t is the elapsed time interval. A constant acceleration curve is well adapted to many of the problems of cam motion, possessing the advantages of starting smoothly from rest, speeding up uniformly to a maximum velocity, and then slowing down uniformly. Due to the acceleration being constant the maximum value of acceleration is less than with any other type of motion.

For purposes of motion study, two parabolic curves are generally used, intersecting at the midpoint of both stroke and distance, *Fig.* 1. If measurements are taken from either end of the stroke, each half of the motion may be expressed

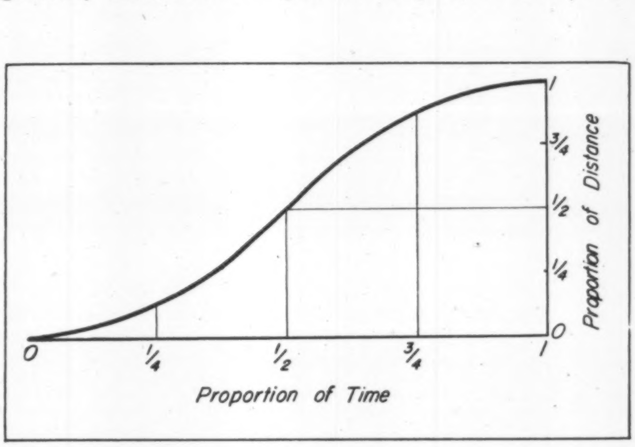


Fig. 1—Motion of cam having constant acceleration and deceleration is represented by two parabolas

$$d = \tfrac{1}{2} a t^2 \; (0 \leqq t \leqq \tfrac{1}{2})$$

It should be noted that it is not necessary to have both curves equal and opposite, provided the two parabolas are tangent at their intersection. However, symmetrical motion is generally desirable for simplicity and is assumed in this data sheet.

In the general equation, d represents a proportion of the distance and t a proportion of the total time. Knowing that $d = \tfrac{1}{2}$ when $t = \tfrac{1}{2}$, a may be found. Substituting in the foregoing equation, $\tfrac{1}{2} = \tfrac{1}{2} a (\tfrac{1}{2})^2$; whence $a = 4$ and

$$d = 2 t^2$$

Also, by differentiating, the velocity is

$$v = 4 t$$

The alignment chart on the following page is based on these equations. For practical purposes the proportionality of distance and time have been broken up to permit a direct reading of actual values:

$$\left(\frac{d}{D}\right) = 2\left(\frac{t}{T}\right)^2$$

where D = total stroke, T = total time, d = distance from start (or end) of stroke, and t = time from start (or end) of motion.

The chart greatly simplifies the labor involved in solving the foregoing equations, and enables the effect of varying time and distance or both to be readily studied. The following example illustrates its use.

A cam imparts a motion of 8⅛ in. in 180 degrees of cam rotation. How long does it take to move 1¼ in. and what is the velocity at that instant?

Draw a line through 8⅛ on the D-scale and 1¼ on the d-scale, intersecting the velocity scale at 1.11. Through this point and 180 degrees on the T-scale, draw a line intersecting the t-scale at 50 degrees. This is the answer to the first question.

To find the instantaneous velocity first compute the average velocity, which is the stroke divided by the time to complete the stroke. If T denotes the angle turned through by the cam in this time and N is the rpm of the cam, this time is $T/360\ N$, hence the average velocity is

$$V_{avg} = 360\ ND/T$$

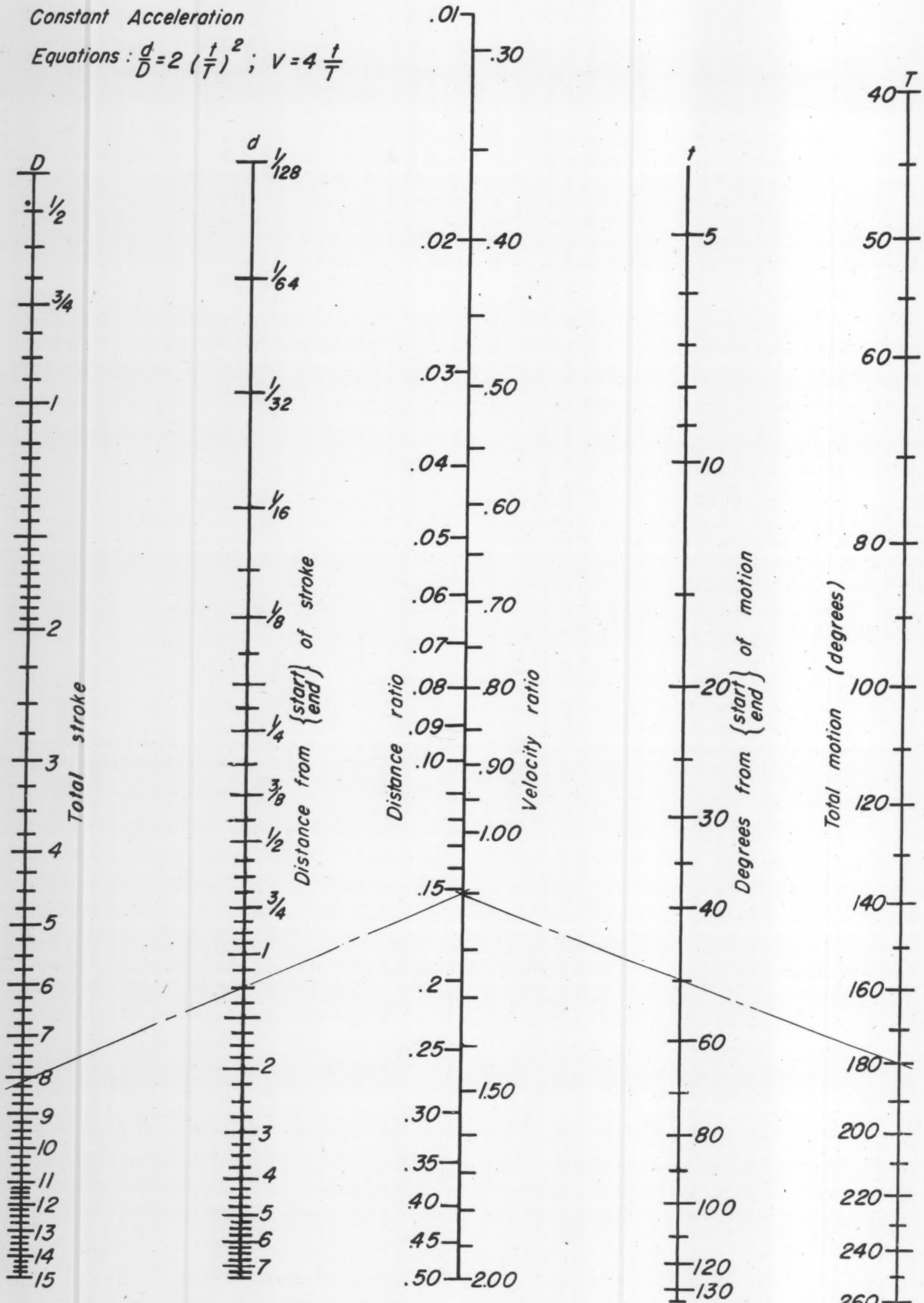
The instantaneous velocity is the average velocity times the velocity ratio found from the chart.

For the foregoing example, $V_{avg} = 360 \times N \times 8\tfrac{1}{8}/180 = 16.25\ N$, and the required instantaneous velocity is $1.11 \times 16.25\ N = 18.04\ N$. If $N = 100$ rpm, for example, the velocity is 1804 in. per min.

Problems involving strokes beyond the range of the chart may be worked by multiplying by a factor to adapt them to the scale.

Constant Acceleration

Equations : $\frac{d}{D} = 2\left(\frac{t}{T}\right)^2$; $V = 4\frac{t}{T}$



Example : A cam has a motion of 8 1/8 in 180°
How long does it take to move 1 1/4 ? Connecting
known points and using the center scale as ref. find 50°

new parts and materials

To obtain additional information on these new developments see Page 257

High-Pressure Needle Valve

PRECISION NEEDLE VALVE for gage and metering lines, etc., is suitable for working pressures to 3000 psi and for temperatures to 750 F. The valves, which are available in both globe and angle types in sizes from ⅛ to ¾-inch, are made of cadmium plated carbon or chrome steel to suit specifications. Union nut construction of the valve is said to prevent dangerous blow-outs during opening or repacking and make possible extra deep stuffing box. Positive back-seating allows the valve to be safely repacked under full line pressure. A metal-to-metal line seal at the bonnet eliminates the use of gaskets, and full port clearance prevents interference with flow characteristics by the nipples. Manufacturer: Kerotest Mfg. Co., 25258 Liberty Ave., Pittsburgh 22.

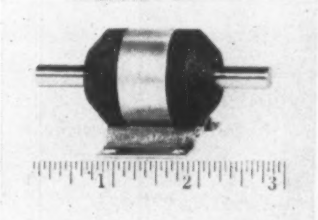
For further information circle MD 1 on card Page 257.

Locking Fastener

RUBBER GROMMETS are now available to take the place of metal grommets used in the Lion fastener to hold locking stud in position. Rubber grommet holds stud snugly in place and can be applied without any special tools. It allows quick, easy replacement of studs by longer or shorter studs to provide for variation in sheet thickness. Rubber grommet is especially useful where air or water seal is required. Manufacturer: Lion Fastener, Inc., East Main St., Honeoye Falls, N. Y.

For further information circle MD 2 on card Page 257.

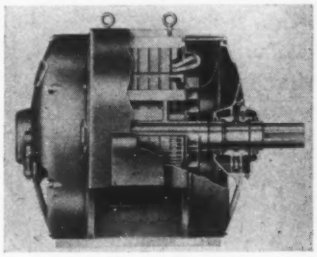
Miniature Speed Changers



MINIATURE SPEED CHANGERS, capable of transmitting torques as great as 2 lb-in. at speeds up to 20,000 rpm, measure only 2 11/16 inches long and 1 1/16 inches in diameter. Of spur gear construction, the speed changers are capable of power transmission in either direction in speed ratios from 10:9 to 15:1. Drive shafts are coaxial and are mounted in permanently-lubricated ball bearings. Intermediate gears are mounted in graphite-impregnated plastic bearings, so that no lubrication is required except under high loads. Manufacturer: Metron Instrument Co., 432 Lincoln St., Denver 9.

For further information circle MD 3 on card Page 257.

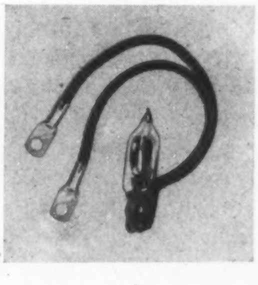
Heavy-Duty Induction Motors



DRIP and splash-proof squirrel-cage induction motors, newly available, are rated at 100 to 1000 horsepower, 1800 rpm and lower speeds. Motors have fabricated steel frame, and access plates designed for speedy removal. Sealed bearings may be cleaned and refilled without motor disassembly and double-end ventilation is provided by a blower at each end of the rotor. Starting characteristics are NEMA Class B (normal torque, low starting current) for across-the-line starting. Manufacturer: Electric Machinery Mfg. Co., Minneapolis 13.

For further information circle MD 4 on card Page 257.

Mercury Switches



HERMETICALLY SEALED and thus unaffected by moisture, dust or corrosion, new Chatham mercury switches are available in multiple or single-contact types. Any contact arrangement, including polyphase types can be provided. Units are compact, light in weight, and are capable of quick make-and-break. They are recommended for use in areas where explosion or fire hazards exist, because of inherent elimination of open sparking or arcing. Manufacturer: Chatham Electronics, 475 Washington St., Newark 2, N. J.

For further information circle MD 5 on card Page 257.

Aluminum-Clad Steel

LOW CARBON STRIP STEEL clad with aluminum is now available either as a duplex metal with aluminum on one face or a triplex metal with aluminum on two faces. The material has a ductile bond between the two metals, permitting the stock to be formed or drawn into intricate shapes without fracturing the inner layer or loosening of the coating. Clad sheet is recommended for applications such as sleeve bearings and conditions where the anti-corrosive properties of aluminum are desirable. Stock is standardized in 2S aluminum although other aluminum alloys are available. Manufacturer: P. R. Mallory & Company Inc., 3029 E. Washington St., Indianapolis 6.

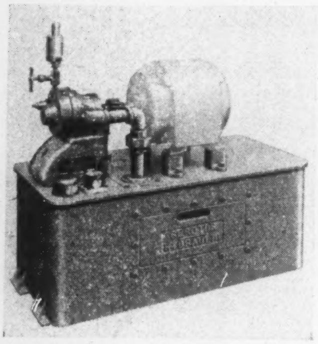
For further information circle MD 6 on card Page 257.

Cable Connector

COAXIAL cable connector for making efficient water-tight coaxial-cable connections for antennas, etc., now is being offered by Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa. The connector, known as Type CC-50, is aluminum with steatite insulation and has forged-steel eyebolts equipped with soldering connections. Five-eighth inch rubber tubing and cement for installation is supplied with each connector. Assembled unit weighs 12 oz., will also serve as center insulator for half-wave doublet.

For further information circle MD 7 on card Page 257.

Hydraulic Pump



PUMP UNITS incorporating tank filler and pressure gage are designed to deliver a steady oil flow at continuous working pressures up to 1000 psi. Pump units come complete with tank, filler, screen and breather cap, oil-level indicator, pressure gage and gage head-off valve, adjustable relief valve, flexible coupling and piping. Units are furnished standard for any NEMA frame motor but special motors may be mounted. Units with single pump, known as Series 9100, operate at 1200 to 1800 rpm with tank capacities of 4½, 10, 17½, 35, 60 and 100 gallons. Units having double pumps with two separate circuits, Series 9200, operate at 1200 rpm with tank holding 10, 17½, 35, 60 or 100 gallons. Manufacturer: Gerotor May Corp., Maryland Ave. & Oliver St., Baltimore 3, Md.

For further information circle MD 8 on card Page 257.

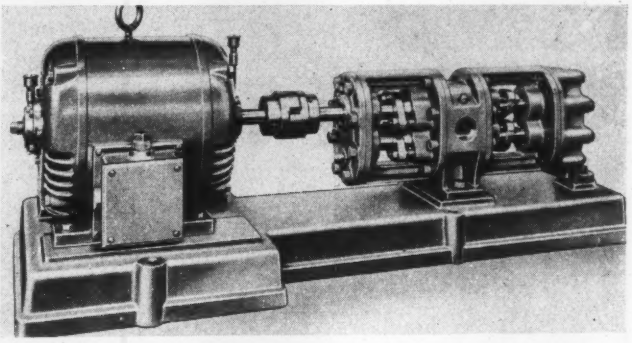
Electric Motor

UNIVERSAL GEAR-MOTOR known as DUR-531 operates on 115 volts ac or dc developing a torque of 3.7 pound-inches at 120 rpm for intermittent duty. Motor housing is die-cast and totally enclosed while worm gear is laminated Bakelite. Gear housing is grease packed for thorough and long-life lubrication. Armature and field windings are doubly impregnated and baked, and armature bearing at commutator end is grease-sealed ball bearing. New type motor is recommended for applications such as vending machines, remote controls, cam operation, instruments and the like. Manufacturer: John Oster Manufacturing Co., 1 Main St., Racine, Wis.

For further information circle MD 9 on card Page 257.

Rotary Pump

MEDIUM-DUTY gear type pumps suitable for pumping materials such as oils, varnishes, and chemical solutions have capacities varying from 1 to 550 gpm with discharge pressures up to 250 psi. The pumps are available in two models: The external-bearing model designed for nonlubricating fluids, and the internal-bearing model for lubricating fluids. Both models are available with either vertical or horizontal mountings. Rotors are the deep-toothed, noncontacting type of small diameter, utilizing the continuous herringbone configuration. Small diameter rotors provide low pitch line and have smooth, quiet and efficient operation. Manufacturer: Sier-Bath Gear & Pump Co., North Bergen, N. J.



For further information circle MD 10 on card Page 257.

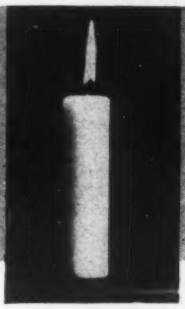
Protective Coatings

COATING designed for application to aluminum and aluminium alloys prior to painting or lacquering reacts chemically with the metal and bonds with it in from 15 to 60 seconds in a single treatment. The coating, which is applied at room temperature by dip, spray or brush, has excellent adhesion and uniformity and is applicable to all forms and alloys of aluminum. Manufacturer: Colonial Alloys Co., Ridge Ave. and Crawford St., Philadelphia 29.

For further information circle MD 11 on card Page 257.

Terminal Headers

GLASS TO METAL hermetic seals in a wide variety of shapes of multiple electrical terminal headers with a 75 per cent saving in material costs have recently been announced. Terminals in headers may be arranged with for *Silent*



Operation

use

SLEEVE TYPE BEARINGS

Johnson Bronze Sleeve Bearings Give You Every Worthwhile Advantage

- LOW COST
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- LONG LIFE
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- UNIT CONSTRUCTION
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- HIGH RESISTANCE TO SHOCK
- LOW COEFFICIENT OF FRICTION
- EASY TO INSTALL
- CONFORMABILITY
- NATION WIDE SERVICE

N*OISE* is usually a source of irritation. In a household appliance it has an adverse effect on the sale of the product. In a machine tool it usually means vibration. Vibration robs the unit of any degree of accuracy in its performance. The best way to deal with noise is to eliminate it.

One easy way to eliminate noise is through the wider use of Sleeve Type Bearings. Their simplified construction . . . no moving parts within the bearing . . . provides an even, unbroken bearing surface. This permits the shaft to build a protective film of lubrication between the bearing and the shaft . . . thereby to operate quietly, efficiently, and for an exceptionally long period of time.

Quiet operation is but one of the many worthwhile features of Johnson Sleeve Bearings. Another . . . and a particularly important feature in today's market . . . is their low cost. Manufacturers of all types of equipment are being pleasantly surprised at the substantial savings they make when they use Johnson Bearings.

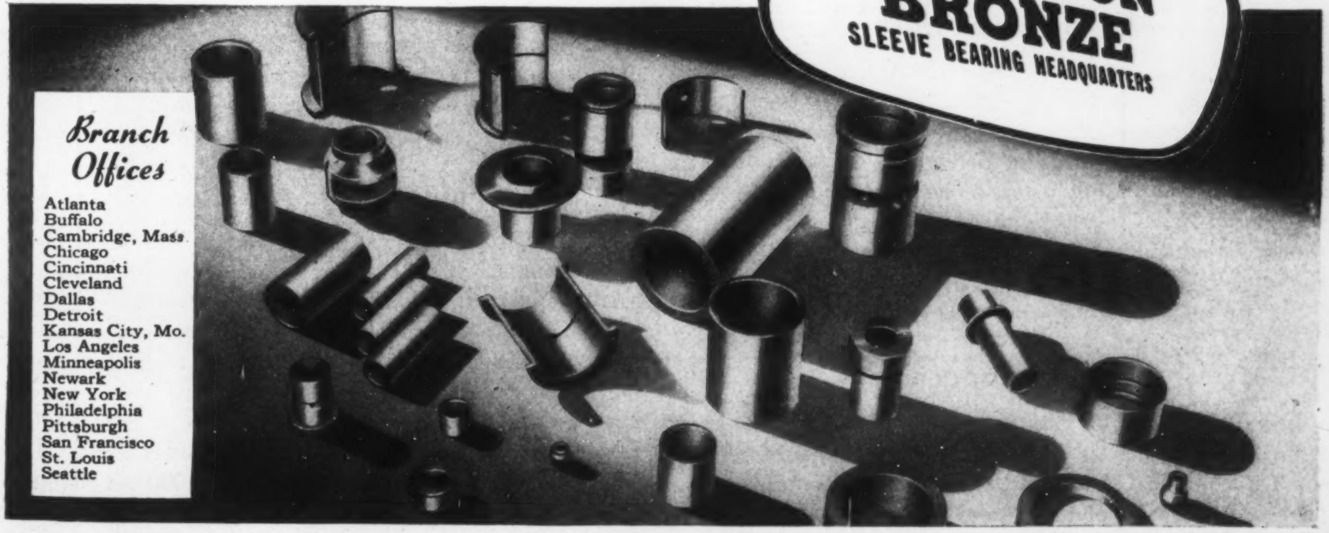
When you are ready to check over your bearing applications . . . to eliminate noise . . . to save money . . . to improve performance . . . call in Johnson Bronze. We manufacture all types of Sleeve Bearings . . . we have over forty years experience . . . and we are ready to serve you NOW.

JOHNSON BRONZE CO.

525 South Mill Street New Castle, Pa.

JOHNSON BRONZE

SLEEVE BEARING HEADQUARTERS



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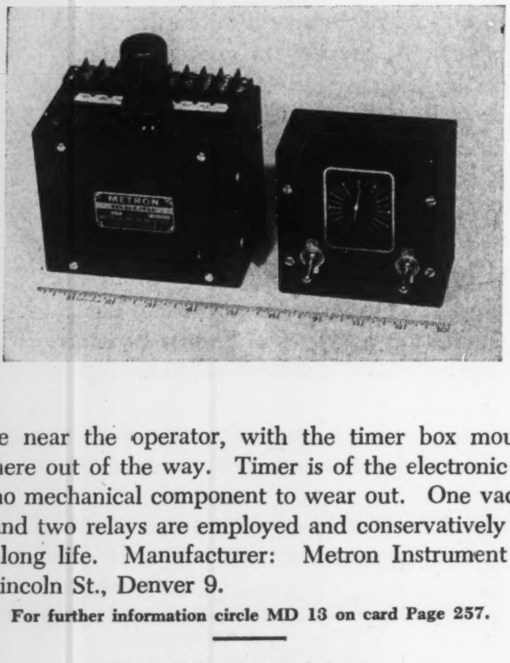
a minimum of spacing in any pattern or combination of voltage ratings. The headers possess a matched coefficient of expansion, are vacuum tight and have a resistance of over 10,000 megohms between body and terminals or between terminals. They have a permanent chemical bond between metal and glass, and are capable of withstanding shock of hot-tin dipping to facilitate soldering. Manufacturer: Hermetic Seal Products Co., 414-418 Morris Ave., Newark 3, N. J.

For further information circle MD 12 on card Page 257.

Electronic Timers

INDUSTRIAL and welding timers of unusually small size, used to measure timing intervals from 1/60-second up to several minutes, are available in several continuously variable ranges. Control box of the timer, measuring only 5 by 4 by 2 inches, can be mounted with bracket or incorporated in machine by flush mounting in any panel surface near the operator, with the timer box mounted anywhere out of the way. Timer is of the electronic type with no mechanical component to wear out. One vacuum tube and two relays are employed and conservatively used for a long life. Manufacturer: Metron Instrument Co., 432 Lincoln St., Denver 9.



For further information circle MD 13 on card Page 257.

Flexible Metal Hose

METAL HOSE, said to withstand internal pressures up to 800 psi, is constructed with a synthetic-rubber tube especially compounded to resist hot water, soapy solutions and chemicals used for detergents. Hose is reinforced with two plies of Ustex, a chemically-treated high-strength textile. Cover is synthetic rubber to resist oil and grease. Manufacturer is the United States Rubber Co., Rockefeller Center, N. Y.

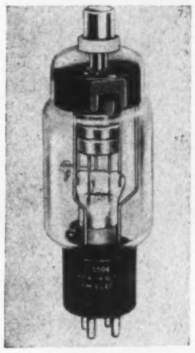
For further information circle MD 14 on card Page 257.

Miniature Capacitors

CAPACITORS with ratings up to 1.0 mfd have high performance under adverse conditions of humidity. Of small size, typical 0.005 mfd (150 volt) capacitor measures 3/16-inch in diameter and 3/4-inch long. Units, known as Miniature Capacitors 63P and 64P are manufactured in both round and flat types in capacities ranging from 0.00025 to 1.0 mfd, have power factor at 1000 cycles of not more than 2 per cent. Manufacturer: Sprague Electric Co., North Adams, Mass.

For further information circle MD 15 on card Page 257.

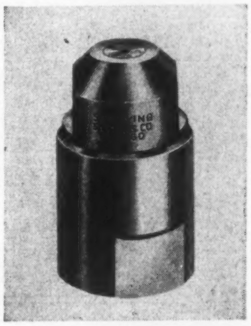
Rectifier Tube



XENON FILLED thyratron tube with characteristics suitable for widely diversified applications does not require auxiliary equipment to maintain bulb temperatures and will operate through the range −55 C to +90 C. The type 5594 tube, operating on a filament voltage of 2.5 volts and a current of 5 amperes, is rated at a peak forward anode voltage of 2500 volts, a peak inverse anode voltage of 5000 volts, an average anode current of 0.5 ampere and a peak anode current of 2 amperes. Manufacturer: Chatham Electronics, 475 Washington St., Newark 2, N. J.

For further information circle MD 16 on card Page 257.

Drying Nozzle



HIGH-CAPACITY spray-drying nozzle used for such operations as milk or egg drying is of stainless steel with wearing parts of hardened steel or tungsten carbide. Unusual design incorporates removable core or spinner which floats in the cap of the nozzle. When nozzle is in operation pressure of the liquid firmly holds core in position. With pressure shut off, nozzle may easily be disassembled and core removed for cleaning. Standard units are built without strainers, although they may be supplied if required. Nozzle is built in many sizes to meet the capacity and spray-angle requirements of all spray using single nozzles. Manufacturer: Spraying Systems Co., 4023-F West Lake St., Chicago 24.

For further information circle MD 17 on card Page 257.

Photoelectric Actuator

PHOTOELECTRIC ACTUATOR for use with electronic counters is suitable for counting large varieties of small objects at high speed. Model 600 actuator has a light beam approximately 1/16-inch wide and will respond to changes in light level as small as 20 per cent. Objects as small as 0.010-inch in size have been counted with precise accuracy. Actuator provides negative pulse required for operation of electronic counters and is designed to detect objects at rates up to 30,000 per minute. The unit also contains a capacitor discharge output cir-

Why we call them "ENGINEERED" packings

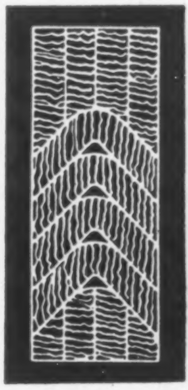
Houghton's hydraulic packings are built for the specific job . . . a la carte, so to speak, and not supplied on a "take-it-or-leave-it" basis. Here's an example:

An equipment manufacturer had continuous trouble due to poor sealing and oil leakage, which no previous packings had solved. The engineer came to Houghton for suggestions.

We drew up a simple design calling for VIM resin-impregnated "V" packings, four to the set (see above) with top and bottom support rings of laminated leather. It worked: no leakage, no failures, lower frictional resistance, permitting more rapid operation of high-speed air-hydraulic units made by that company.

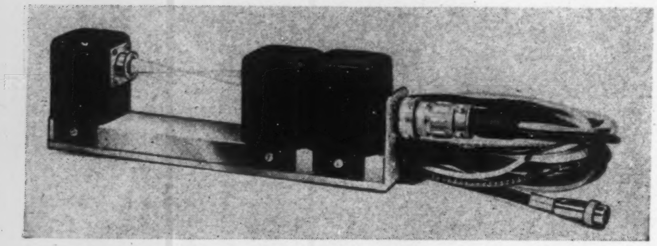
VIM "exceeded every expectation," reports the manufacturer. Which is just another of a long line of victories for VIM Packings and Houghton engineering service.

Our packing line is complete, including leather, synthetic rubber and "O" rings, covering the full range of pressures and temperatures. For advice, and for packings, write E. F. HOUGHTON & CO., 303 W. Lehigh Avenue, Phila. 33, Pa.



HOUGHTON'S

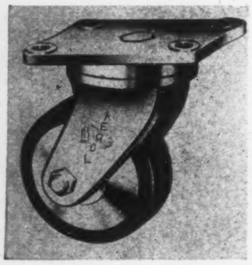
VIM LEATHER and VIX-SYN PACKINGS



cuit for high-speed operation of control solenoids such as required for deflector gates and packaging equipment. Manufacturer: Potter Instrument Co., 136-56 Roosevelt Ave., Flushing, N. Y.

For further information circle MD 18 on card Page 257.

Rubber-Tired Caster



RUBBER-TIRED CASTER is made in both rigid and swivel types. New Aerol caster embodies such features as heavy-duty shake-proof king pin, labyrinth dirt seal to protect lubricated bearings and extra offset for instant trailing. Use of tapered roller bearings on the race assures straight, even tracking and sensitive swivel action even under heavy loads. Both thrust and king pin bearings are factory-greased, roller bearings eliminating axle wear and side-play. Manufacturer: Aerol Co., 1823 E. Washington Blvd., Los Angeles 21.

For further information circle MD 19 on card Page 257.

Copper-Tungsten Alloy

LINE OF copper-tungsten alloys available in the form of rods, bars and inserts is now offered by Ampco Metal, Inc., 1745 S. 38th St., Mliwaukee 4. Main applications of these alloys are for projection and flash welding, die facing and inserts, electrical upsetting and forging dies and similar applications. The new alloy meets RWMA specifications and is available in a number of classes.

For further information circle MD 20 on card Page 257.

Dial-Feed Table

CONTROLLED BY a three-way air valve, dial feed table is indexed and locked in position by operation of piston-driven pawl arm. Table, which operates on 30 to 50 psi air pressure, has all moving parts of hardened bronze working in replaceable bronze or Oilite bushings. Unit measures 9 inches in diameter and 2 15/16 inches high. Manufacturer: The A. K. Allen Co., 311 Fort Hamlton Parkway, Brooklyn 18, N. Y.

For further information circle MD 21 on card Page 257.

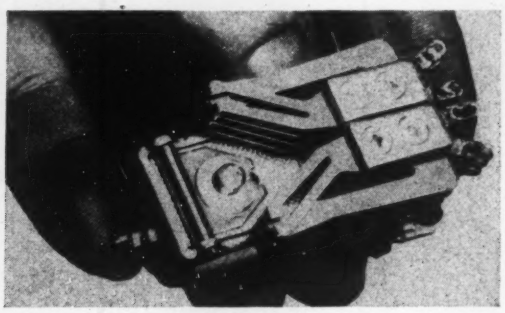
Synchro-Start Engine Controls

FULLY AUTOMATIC starting, stopping and protecting systems for use with internal combustion engines are now available. Line includes governors, solenoids, automatic cranking units, relays and multiple-engine panel boards. Manufacturer: Synchro-Start Products, Inc., 221 East Cullerton St., Chicago.

For further information circle MD 22 on card Page 257.

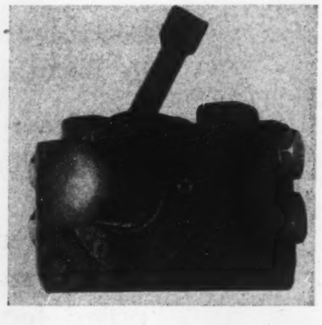
Direct-Current Relays

SMALL LIGHTWEIGHT type J relay utilizes independent twin contacts to achieve extremely fast operation. The unit, which measures 2¼ inches long and weighs 2½ oz, has twin contacts mounted on long, flexible contact fingers of the bifurcated stationary type allowing the contacts to operate independently of each other so that one will close even if the other should be blocked. Other important features include hinge-type armature bearing of new design and contacts capable of carrying 4 amperes, 150 watts. Relay is designed for operation at a minimum speed of one to two milliseconds, and is available in both single and double-arm types. Manufacturer: C. P. Clare Co., 4719 West Sunnyside Ave., Chicago 30.

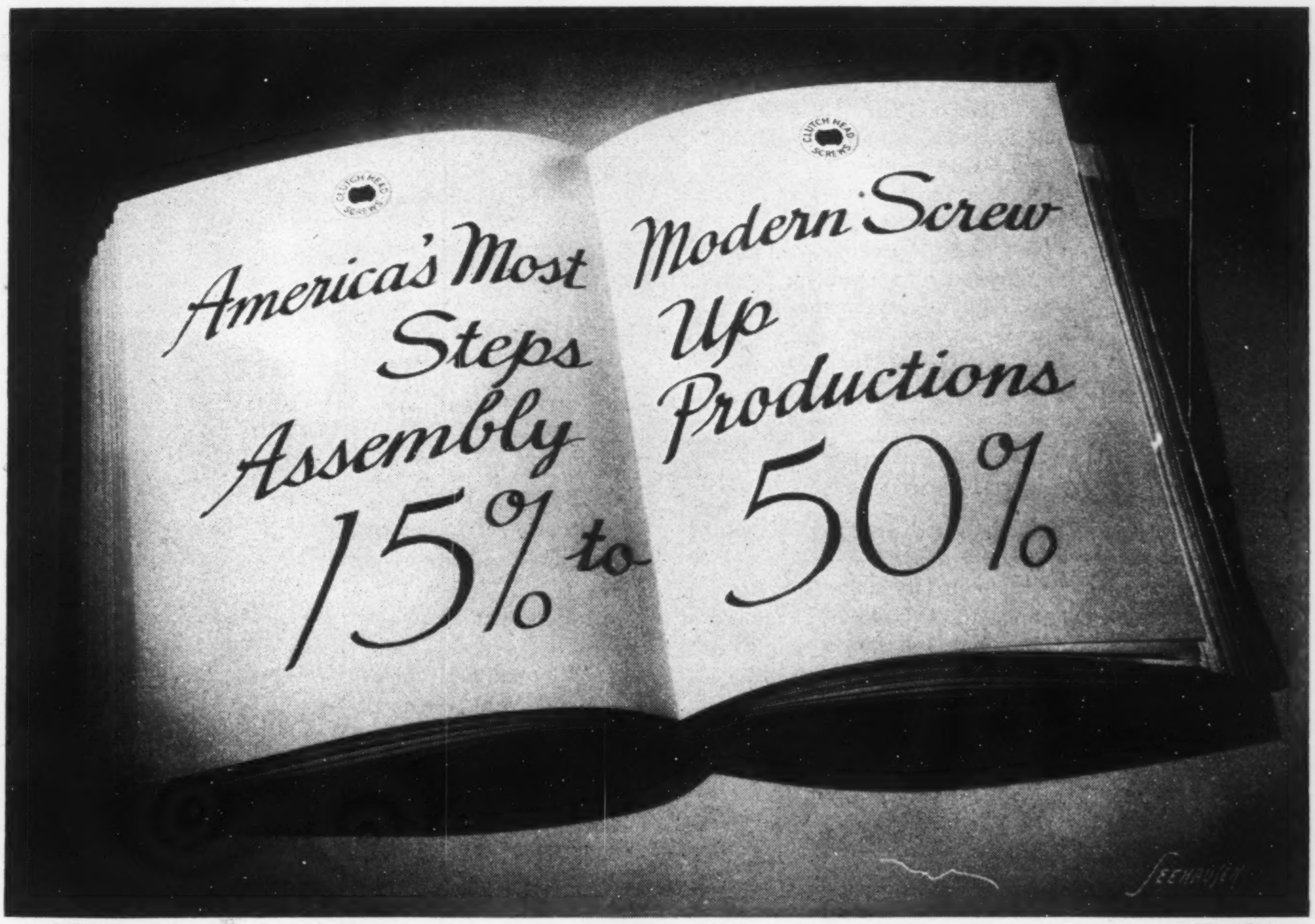


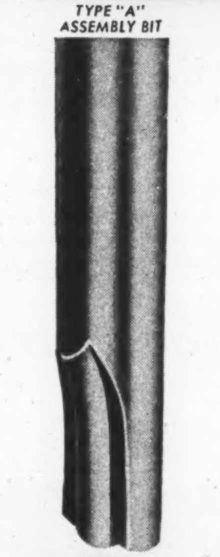
For further information circle MD 23 on card Page 257.

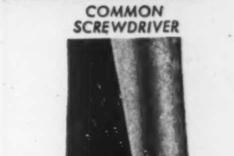
Hydraulic Valves



HYDRAULIC VALVE of 4-port type, suitable for controlling all types of reciprocating cylinders, obtains full reversal actuation from the cylinder itself. Reversal can be accomplished with as little as ½-inch travel. Reverse lever swings through only 45 degree arc and repetitive reversal at the same mechanical position is guaranteed. Features of the new valve include positive mechanical shut-off by knob which springs into stop position, and reverse lever which may be moved to any position without causing cylinder movement or creep. Motion may be resumed by pulling out stop knob







CLUTCH HEAD *Performance Is a Matter of Record*

These few selected quotations, from users of CLUTCH HEAD Screws, tell a definite story of CLUTCH HEAD performance as compared with the use of all other types of screws...not in "test runs," but in day-to-day production.

50% "CLUTCH HEADS sent our production up a straight 50%" ... *Lestershire Spool & Mfg. Co., Johnson City, N. Y.*

30% "Change to CLUTCH HEAD increased our production 30%" ...*France-Sporting Co., New York 12, N. Y.*

22% "Our heater assembly costs cut 22%"... *Monroe Stove Co., Chicago.*

20% "We find a 20% increase in assembly operation" ... *Quam-Nichols Company, Chicago.*

"STEPPED UP PRODUCTION and eliminated cabinet damage" ... *Norge Refrigerator Division, Detroit, Mich.*

20% "Now get SIX instead of FIVE truck body assemblies" ... *The Lindsay Corporation, Chicago.*

15% "A 15% step-up in assembly driving operation" ... *Hicks Body Company, Lebanon, Ind.*

Conclusive evidence like this should indicate the possibility of a substantially increased tempo on your assembly line. In addition to the speed factor, investigate the exclusive CLUTCH HEAD features that contribute to safer, easier, lower-cost driving, plus simplified field service. Send for screw assortment, sample Type "A" Bit, and Brochure.

UNITED SCREW AND BOLT CORPORATION

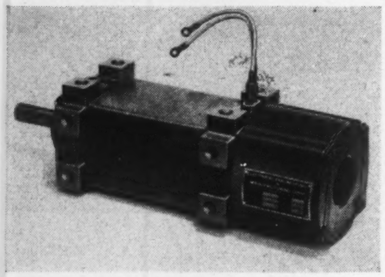
CLEVELAND 2 CHICAGO 8 NEW YORK 7

and turning 90 degrees to detent position. The valve operates under pressures from 50 to 300 psi and is available in pipe sizes from ⅛ to 1 inch. Unit requires four pipe connections—pressure input, line return, cylinder forward and cylinder reverse. Mounting is supplied in flange, bracket or face types with O-type packings. Models of the Rite valve may be supplied to operate on pressures under 50 or over 300 psi, and fully automatic, semiautomatic or manually-operated cycling can be provided. Manufacturer: R. I. Task Enterprises, Inc., 250 Auburn St., Cranston 10, R. I.

For further information circle MD 24 on card Page 257.

Universal Motor

UNIVERSAL TYPE motor rated at 2 hp operates at 5700 rpm making it especially adaptable for direct connection to high-speed apparatus. The motor is of the continuous-duty type operating on 115 volts dc or ac, 25 to 60-cycle. It is totally enclosed and fan cooled, weighs 22 lb. Length of the motor is 14¾ inches including shaft extension, and diameter is 5 inches. The unit fits in a 5¼-inch shell. Features include aluminum castings, high-temperature varnishes, and glass-fiber insulation. Manufacturer: Electrical Engineering & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles.



For further information circle MD 25 on card Page 257.

High-Pressure Hose Coupling

TRIPLE-SEAL high-pressure hose coupling designed for both air or steam lines has been developed by the Eas-E-Go Products Division, Main Machine Co., Stamford, Conn. Coupling contains a positive-action sure-seal, lock, precision-built on the principle of ring expansion and contraction. It includes a ball-seat lock with duct, allowing a full-flow air stream and eliminating any possibility of leakage.

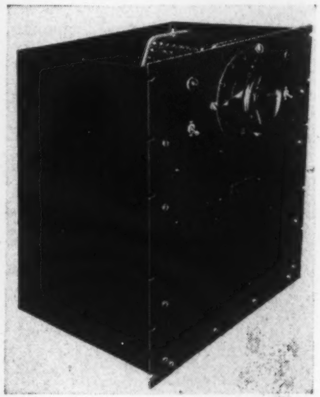
For further information circle MD 26 on card Page 257.

Variable Pitch Pulleys

VARIABLE-PITCH pulleys, capable of infinite adjustment in the range provided, lock on shafts without use of set screws, threads or keyways. This is achieved by means of a spiral wedging action, and pulley is in rigid alignment when so locked. Unit is said to be particularly suitable for use with air conditioning, refrigerating and ventilating equipment; and air compressors and conveyors, etc. Manufacturer: Scientiae Corp., 103 Pine St., Dayton 3, O.

For further information circle MD 27 on card Page 257.

Power Supply

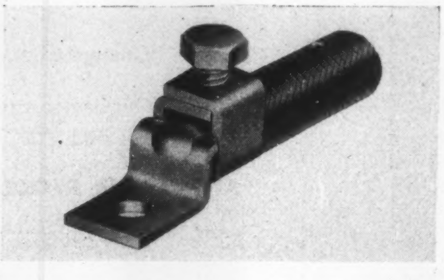


SUPPLYING dc power in the 0-3000 volt range, Seco dc power supply operates on 115-volt, single phase, 50 to 60-cycle current. The unit is a full-wave bridge-type rectifier consisting of four type 866/866A tubes. A time-delay relay is provided to allow the filaments to be adequately heated before high voltage is applied and line fuses are incorporated for protection against the possible overload conditions. All major components are either potted in metal enclosures or are hermetically sealed. The unit, which will supply 0.5- ampere current, is supplied for mounting on a standard 19-inch relay rack panel. Manufacturer: Superior Electric Co., 180 Church St., Bristol, Conn.

For further information circle MD 28 on card Page 257.

Electrical Fittings

TERMINAL LUG known as the Lug-it will accommodate either stranded or solid wire in sizes from No. 14 to 4/0. The fitting is made of bronze for high strength, and has double thickness of metal at the location of the screw threads thus making possible great tightening force. Passing through the lug body, the serrated lug tongue has direct contact with the wire to provide low contact resistance. Manufacturer: Thomas & Betts Co., Inc., 36 Butler St., Elizabeth 1, N. J.

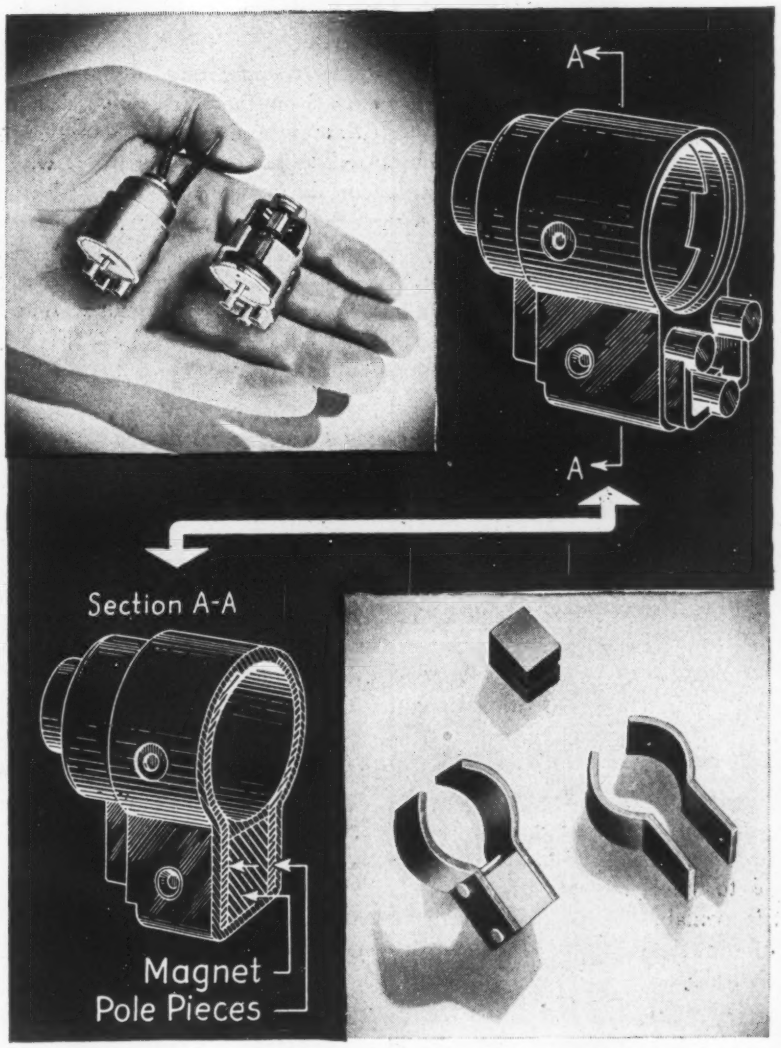


For further information circle MD 29 on card Page 257.

Electronic Positioning-Control System

REMOTE POSITIONING control system utilizing either selsyns or potentiometers for positioning of valves, etc., can be used on drives up to 1½ horsepower. The

PRACTICAL CONSIDERATIONS IN DIE CASTING DESIGN



ALLOY SELECTION

Equally important to the design of a die casting is the selection of the proper alloy for its production. The zinc alloys used in the die casting industry conform to specifications of the American Society for Testing Materials and the Society of Automotive Engineers (see table below). When a casting is properly designed and the alloy composition is carefully controlled with respect to every element involved, outstanding mechanical properties and dimensional stability will be assured in zinc alloy die castings.

Zamak* and Corresponding A.S.T.M. and S.A.E. Alloys

	A.S.T.M.	S.A.E.
Zamak-3	XXIII	903
Zamak-5	XXV	925

*A trade mark (registered in the U. S. Patent Office) identifying the zinc alloys developed by The New Jersey Zinc Company and used in the die casting industry.

For additional data on die casting design ask us—or your die casting source—for a copy of the booklet "Designing For Die Casting."

INSERTS PROVIDE SPECIAL PROPERTIES

In designing die castings, keep in mind that inserts of various materials can be cast in place to obtain special properties, or to provide passages so located that they cannot be cored or cast. In addition to metals in the form of stampings, forgings or screw machine parts, commonly used insert materials in die castings are plastics, pressed paper, cloth, wood fibre and porcelain.

The above *zinc alloy* die cast housing for a vest-pocket size motor is a good example of the use of inserts to endow a casting with electrical properties (the motor is powered with a small "A" battery of the hearing aid type). Cast in place in this housing is an assembly of two steel pole pieces and an aluminum- nickel- cobalt magnet (see lower photograph). This use of inserts not only simplifies assembly of the midget motor, but the magnetic elements are accurately located and permanently anchored in the housing.

Inserts should be employed whenever their use attains results that cannot be realized at equal cost by other means. Since the positioning of inserts in a die slows the casting rate and, consequently, increases casting costs, designers will do well to determine the desirability of applying inserts after casting—in holes cored for the purpose.

Send for your copy ➡

DESIGNING FOR DIE CASTING

ZINC
FOR DIE CASTING ALLOYS

The New Jersey Zinc Company, 160 Front St., New York 7, N. Y.

The Research was done, the Alloys were developed, and most Die Castings are based on

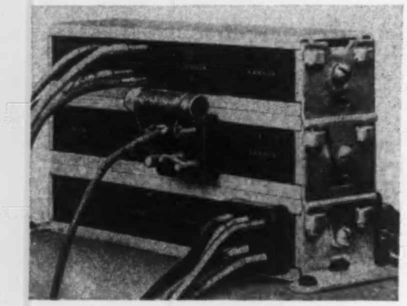
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

control consists of three elements: Master control station, a follow-up device and an electronic control panel. The driving motor is not included in the system since a reversing ac or dc motor with an adequate capacity is acceptable. To operate, a dial is set in the same manner as a radio dial, and the motor moves the load to a new position corresponding to that on the dial. Manufacturer: General Electric Co., Schenectady, N. Y.

For further information circle MD 30 on card Page 257.

Terminal Block

COMPACT, flexible terminal disconnect device for low-current circuits is identical on both sides and permits through plugging. Both sides of the unit may be plugged in with either six-contact or single-contact plugs. They may be arranged multiple to single or single to single contacts. A crimp-type single contact to suit is available in addition to the solder-pot type. Feature of the Type Y6 block is ease with which units may be added. Manufacturer is Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31.



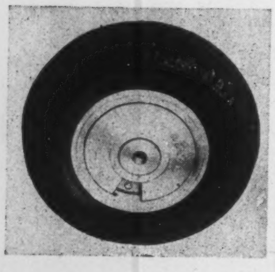
For further information circle MD 31 on card Page 257.

Hard Facing Electrode

HIGH-CARBON ELECTRODES for building-up welding with low-voltage ac transformers as well as dc, are announced by the Lincoln Electric Co., Cleveland 1, Ohio. New electrodes are designated as Hardweld 50 AC and Hardweld 100 AC differentiating them from Hardweld 100 and Hardweld 50 which operate on dc only. Electrodes have a heavily-extruded shielded-arc coating producing flat, smooth beads that may be hot forged.

For further information circle MD 32 on card Page 257.

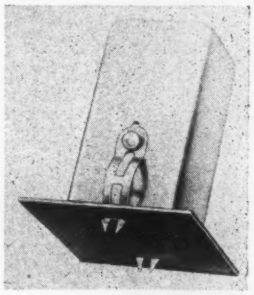
Pneumatic Wheels



NEW TYPE PNEUMATIC WHEEL has a detachable rim, making it possible to change tires in less than one minute. Corrosion - resistant aluminum alloy wheel casting has two sections. One includes bearing, carrying part of the wheel and one rim; the other, the detachable rim, retains the rubber tire by sliding into position over the main part of the wheel, and is held in place by a special steel-spring retainer ring. Double-wall construction has been used on the Aerol wheels to obtain lightness plus strength and durability. They are equipped with factory-lubricated tapered roller bearings which do not require lubrication during their lifetime. The wheels are available in three axle sizes: 1¼ inch, 1 inch, and ¾-inch. The hub diameter is the same for all wheels, with a ¾-inch bearing allowing sufficient stock in the wheel walls for mounting of a sprocket. Manufacturer: Aerol Co., 1823 East Washington Blvd., Los Angeles 21.

For further information circle MD 33 on card Page 257.

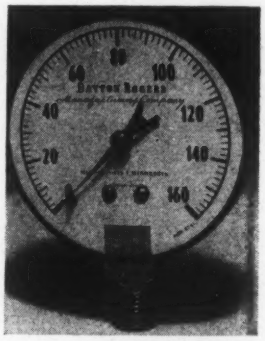
Shield-Can Fasteners



NEW FASTENER provides many advantages for mounting shield cans to radio chassis. It snaps quickly into chassis holes and automatically locks with a strong, positive grip. Two pronged ends of the fastener compress to enter, then snap outwardly when pushed through holes. Prongs grip the underside of the chassis with a continuous spring pull. Fastener accommodates a wide range of thicknessess and variations in hole locations. Manufacturer is the Palnut Co., 75 Cordier St., Irvington 11, N. J.

For further information circle MD 34 on card Page 257.

Pressure Gages



ANNOUNCEMENT of a complete new line of streamlined pressure gages with nonbreakable crystal face and easy to read dial has been made by the Dayton Rogers Mfg. Co., 2835 Twelfth Ave., Minneapolis 7. Gage has movement constructed to absorb all shocks from severe use, assuring long life under all conditions. Gage, of the Bourdon approved type, is suitable for any liquid or gas and will not corrode from steam, etc.

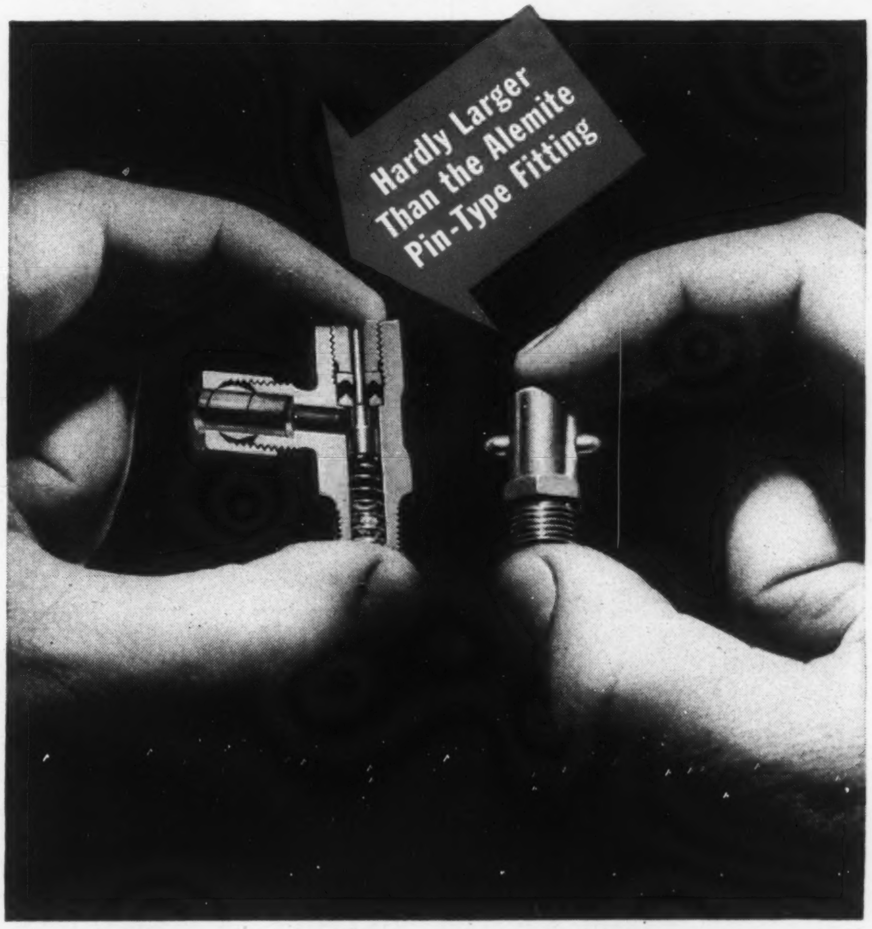
For further information circle MD 35 on card Page 257.

Engine-Generator Set

SELF-EXCITING engine generator sets consisting of Briggs & Stratton ZZP engines and Kato generators will supply 2500 watts, ac power. The generators are self-starting so designed that the dc winding has capacity to charge a standard 32-volt battery. Set is complete with battery charging relays so that the charging rate automatically adjusts itself. When plant is carrying full ac load

Another Alemite "Cost-Cutter"...

NEW ALEMITE "MIDGET" LUBRICANT MEASURING VALVE

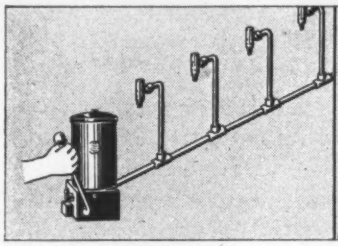


Now You Can Apply Low-Cost Centralized Lubrication to Any Machine

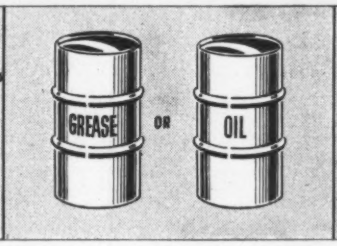
SMALL, SIMPLE, COMPACT . . . this new Alemite "Midget" measuring valve is less than 1½ inches long. In fact, it is not much larger than the popular Alemite fitting used on thousands of machines in every type of industry.

The small sizes of the "Midget," and its simple design, make it suitable for application to all types of heavy, light and precision machines—especially where space limitations are encountered.

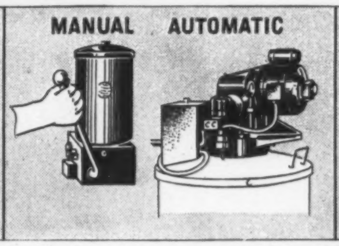
ASK FOR ANY TECHNICAL HELP. Alemite Lubrication Specialists will gladly work with you on any lubrication problems. Their training and experience enable them to render valuable on-the-spot assistance. For an interesting conference and demonstration, write to Alemite, 1804 Diversey Parkway, Chicago 14, Ill.



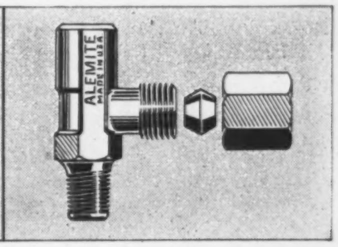
Low Cost, Single Line System. The valves can be mounted on or near bearings, to deliver a measured amount of lubricant from one central point while the machine is producing. No shutdowns, no bearing failures.



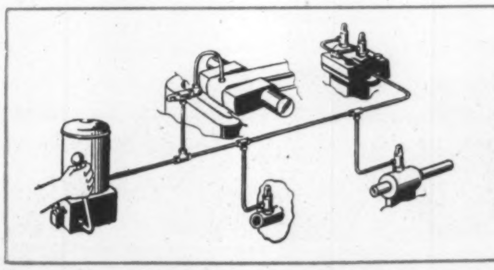
Handles Oil or Grease. There is no danger of over-lubrication or under-lubrication. An indicator signals when the lubrication is completed — eliminating human error. Production goes up . . . costs go down.



Manual or Automatic Operation. A hand pump may be installed in a safe, convenient place on the machine. Or, an Alemite air or electrically operated control will handle a group of machines automatically.



Built-In Compression Fitting is an integral part of the valve and included at no extra cost. No additional fitting is needed to connect tubing to the valve. This is an exclusive Alemite feature.



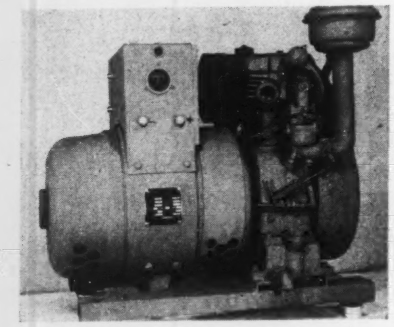
Serves Any Type of Bearing. Installation accessories are available so that the system can be adapted to rotary, oscillating, stationary — plain or anti-friction bearings.

ALEMITE
REG. U. S. PAT. OFF.

Modern Lubrication that Cuts Production Costs

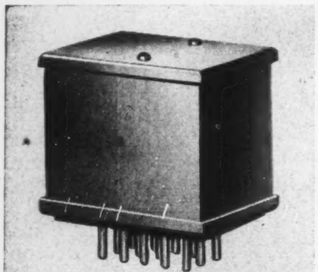
Another Product of
STEWART WARNER

there is very little dc battery charging, while when plant is carrying only a partial ac load, battery is charged at a proportionally greater rate. Motor generators are available with gravity-feed gasoline tanks or fuel pumps to permit drawing fuel from large underground supply tanks. Length is 28 inches, width 20 inches and height 26 inches; net total weight 380 lb. Manufacturer: Kato Engineering Co., Mankato, Minn.



For further information circle MD 36 on card Page 257.

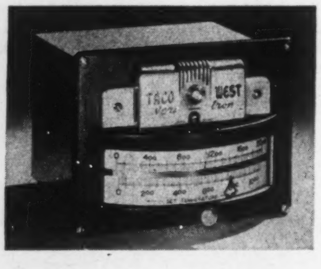
Automatic Rheostats



AUTOMATIC CURRENT CONTROLLER, for applications such as controlling the current supply to rectifiers, amplifiers and generators, operates on dc and will provide output current ranging from 0.025 to 5.0 amperes. Consisting of a solenoid, an armature and multiple contact fingers, the unit provides automatic control as soon as circuit is energized and has a control sensitivity of ±2 per cent or better. Ten steps of control resistance, providing up to 8 watts per step with 80 watts total, require one watt. Manufacturer: Electric Regulator Corp., 1915 Park Ave., New York 35.

For further information circle MD 37 on card Page 257.

Temperature Controller

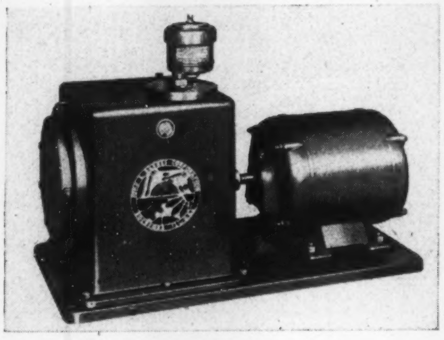


PYROMETRIC temperature controller of unusually compact design is especially suitable for incorporation into body of the machine being controlled. Electronically-controlled instrument actuates an integral 3-kw relay which handles the load, thus permitting greater delicacy and accuracy of instrument movement. Electronic circuit requires no tuning or other adjustments by the user at any time. Design includes no high-frequency oscillator systems, capacitance systems or mechanical clamping mechanisms. Measuring system and electronic mechanism are separately housed in sealed units that plug-in to the instrument case. The complete instrument measures only 5¼ by 5¾ by 7⅛ inches, is available in either flush or surface mounting. Manufacturer: Taco West Corp., 2620 South Park Ave., Chicago.

For further information circle MD 38 on card Page 257.

Hydraulic Pump Unit

HYDRAULIC UNIT providing pressures up to 500 psi is designed for actuating lathe chucks, clamping cylinders, etc. Unit, which measures 25½ by 12 by 12¾ inches high, uses a ¼ to ½-horsepower motor to provide ½-gallon per minute of oil with a maximum displacement per operation of 50 cubic inches. Manufacturer: John S. Barnes Corp., Rockford, Ill.

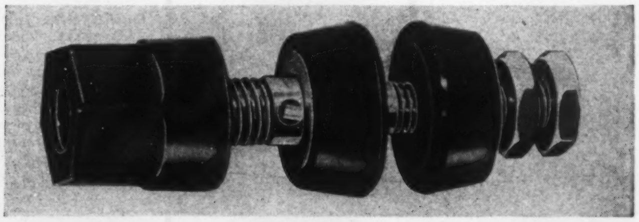


For further information circle MD 39 on card Pige 257.

Electrical Binding Post

MULTIPURPOSE electrical binding post provides five ways of connecting lead wires. Wires may be clamped through center hole or looped around post between nuts. It may also be connected with standard banana plug, clip-lead or space-lug. Type DF30 post provides complete insulation from mounting panel. To assure sturdy construction, extra-strong, hard, phenolic material is used for the head and sliding members. All metallic components are recessed assuring a non-conducting exposed surface for instrument and user protection. Post has a current-carrying capacity of 30 amperes and will mount on any panel up to ¼-inch thick. Manufacturer: Superior Electric Co., 480 Church St., Bristol, Conn.

For further information circle MD 40 on card Page 257.

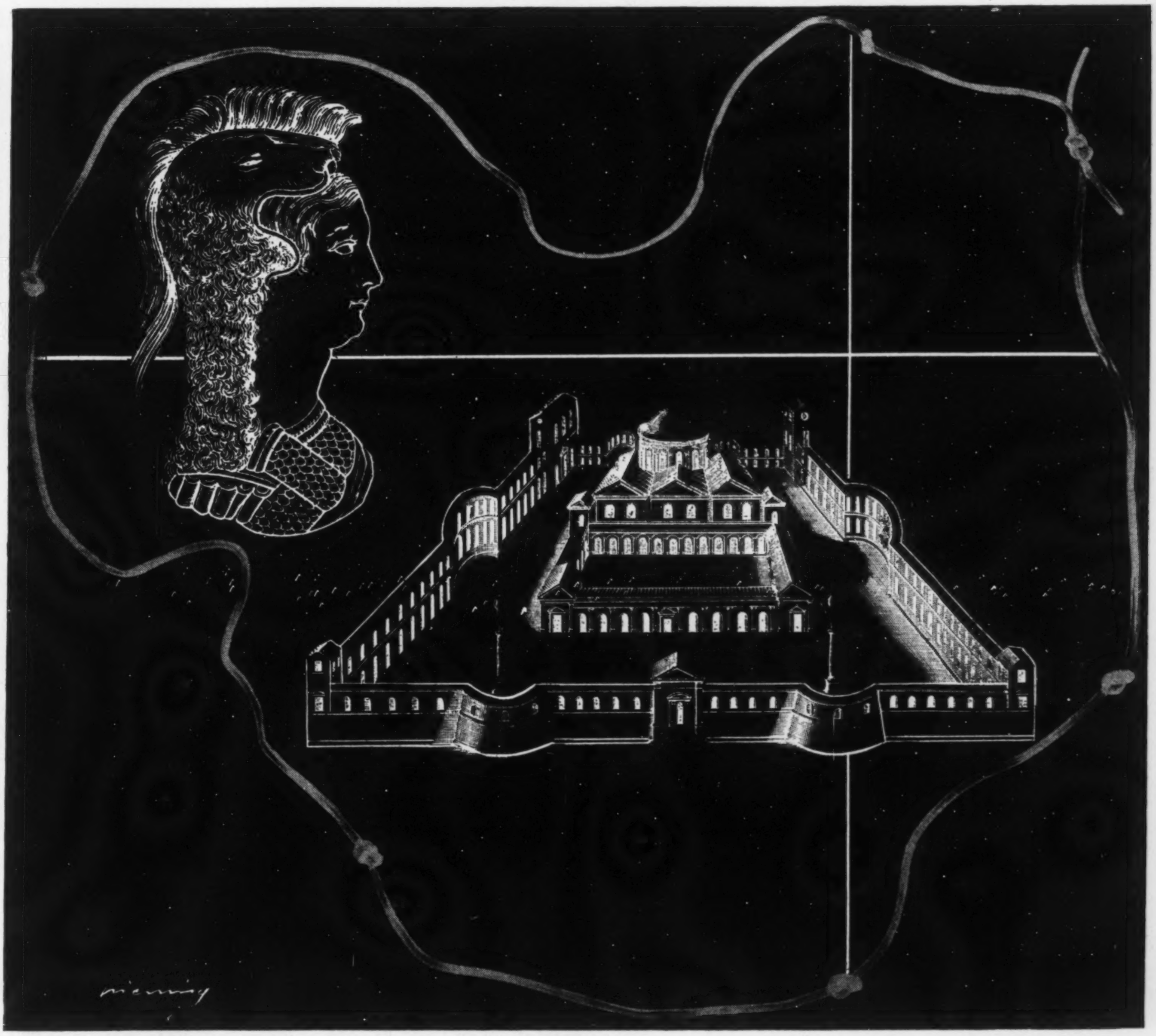


A LITTLE DOES A LOT

According to legend, when the city of Carthage was founded, Queen Dido was told that she could have only as much land as could be encompassed by an ox hide. But the queen made the most of her material by cutting it into a single, continuous leathern string, with which she circled considerable acreage.

Making materials serve to the fullest is just as important to users of steel today as it was to Dido. Except that today no tricks are necessary.

It can be done in many instances by specifying molybdenum steels. Their hardenability, freedom from temper brittleness and good strength-weight ratio help to simplify design problems and insure good performance. It will pay you to investigate their practical advantages.



MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"
CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

MOLY

Climax Molybdenum Company
500 Fifth Avenue • New York City

engineering dept equipment

To obtain additional information on these new developments see Page 257

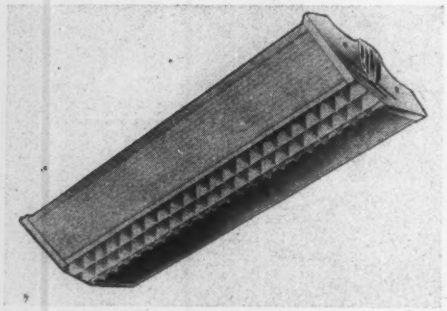
Drawing Set

DRAWING SET includes beam compass with 8 and 13-inch beams, a 6-inch bow compass and ruling pen as well as a refillable drafting pencil. Beam compass features a rapid, positive adjustment of needle and pencil blocks on beam. Slight pressure of the thumb on the tension spring of the blocks allows them to move freely and smoothly, yet a release locks the needle and pencil firmly in desired position. Bow compass draws circles from 1/16-inch to 8 inches in diameter, and drafting pencil has a patented metal chuck that grips lead evenly and snugly. Complete set is assembled in a flocklined, natural-finish mahogany case. Manufacturer: Charles Bruning Co., 4754-18 Montrose Ave., Chicago 41.

For further information circle MD 41 on card Page 257.

Fluorescent Lamp

FLUORESCENT lighting fixture known as Vanguard is a modified V design with egg-crate louvres for maximum shielding of lamps and efficient light diffusion. Side glass panels of frosted, ribbed glass are top hinged to facilitate maintenance, and slotted end sections contribute light to eliminate dark ends. Unit may be mounted in continuous rows without removing ends or using special parts or fittings. Manufacturer: Bright Light Reflector Co., Bridgeport, Conn.



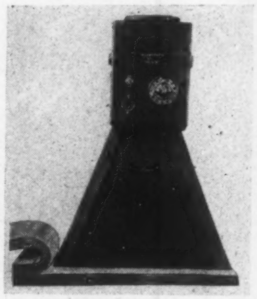
For further information circle MD 42 on card Page 257.

Three-Inch Oscilloscope

PORTABLE 3-INCH OSCILLOSCOPE capable of measuring dc as well as ac, weighing only 8¾ lb, is now available. New model S-11-A includes such features as push-pull amplifiers for horizontal and vertical deflections, intensity modulation amplifier, linear time sweep from 3 cycles to 50 kc, high sensitivity and fidelity of intensity-modulation amplifier which is suitable for television work, anti-astigmatic centering controls and attenuators for ac as well as dc. Manufacturer is the Waterman Products Co. Inc., 2445 Emerald Ave., Philadelphia, Pa.

For further information circle MD 43 on card Page 257.

Photo-Copy Machine



PORTABLE ELECTRIC copy unit for reproducing material measuring up to 8½ by 14 inches is equipped with a collapsible stand fitting over copy to be reproduced. Machine features removable color filter, automatic timer, and is built of heavily reinforced plywood covered with washable fabric. Equipment operates on 115 volts ac. Manufacturer: General Photo Products Co., 15 Summit Ave., Chatham, N. J.

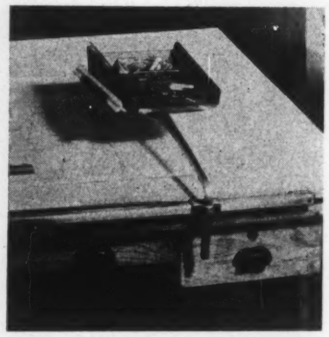
For further information circle MD 44 on card Page 257.

Magnifying Glass

SPECIAL magnifying unit having numerous uses to the engineer is being offered now by Dayton Rogers Mfg. Co., Minneapolis 7. The magnifier has a 1½-inch diameter lens which is mounted on a heavy pressed-steel base. It has full universal mounting and maximum height adjustment of 2 inches.

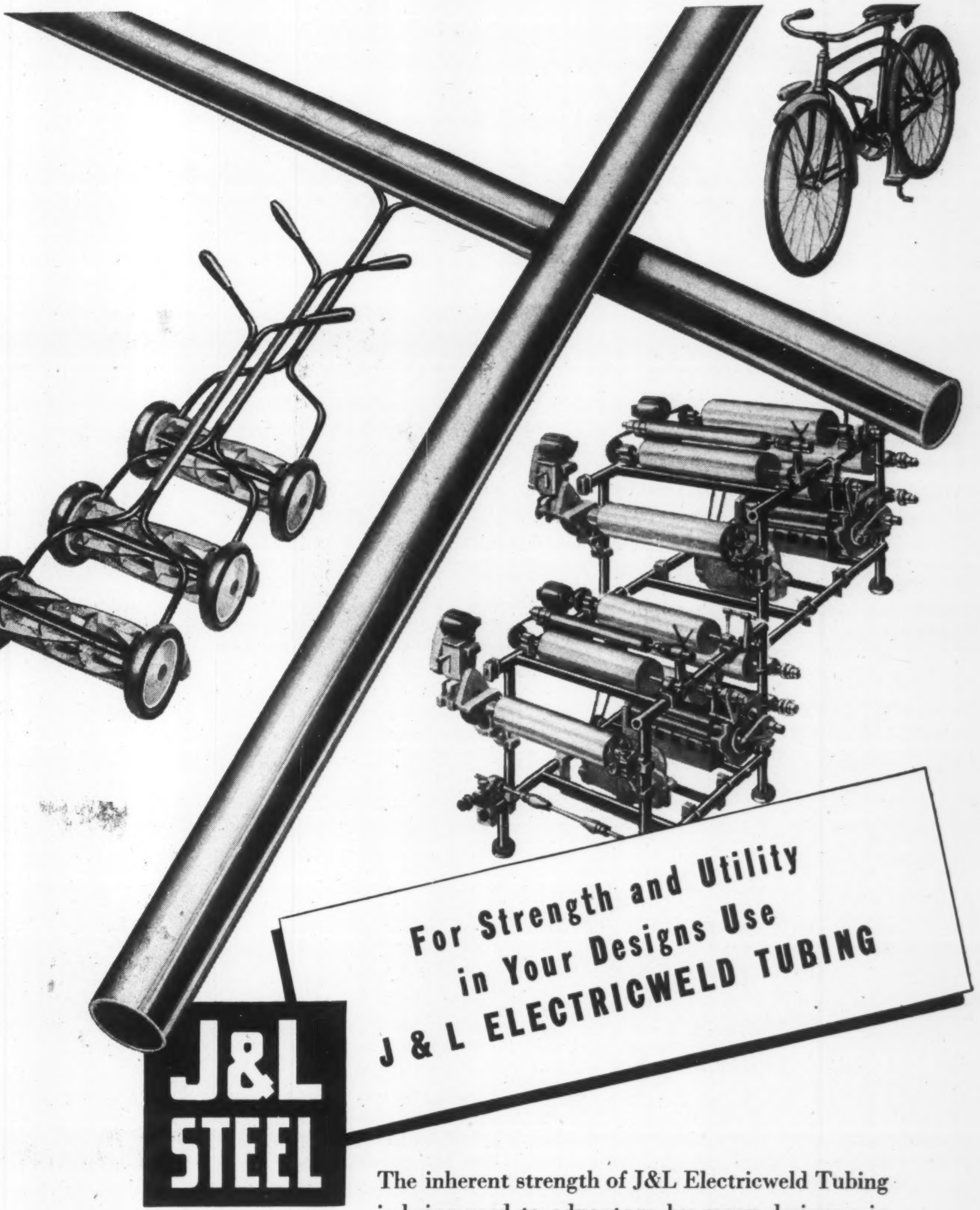
For further information circle MD 45 on card Page 257.

Drafting Tray



AFFORDING designer a spacious and safe place for working tools and accessories, new drafting tray floats above working surface and is readily moved to desired location on drawing table. Height and angle of tray above table surface is quickly adjusted by screw arrangement. Tray has lacquer finish, and is mounted on cadmium-plated bars which are quickly installed with four mounting screws. Manufacturer: A. Wayne Nunemaker & Associates, 103 So. Wells St., Chicago 6.

For further information circle MD 46 on card Page 257.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The inherent strength of J&L Electricweld Tubing is being used to advantage by many designers in making new products where resistance to compression and other stresses without increasing weight are important factors. They find it gives them an opportunity to design better equipment —increase service and eye-appeal.

JONES & LAUGHLIN STEEL CORPORATION
PITTSBURGH 30, PA.

MEN... of... machines

David C. Peterson

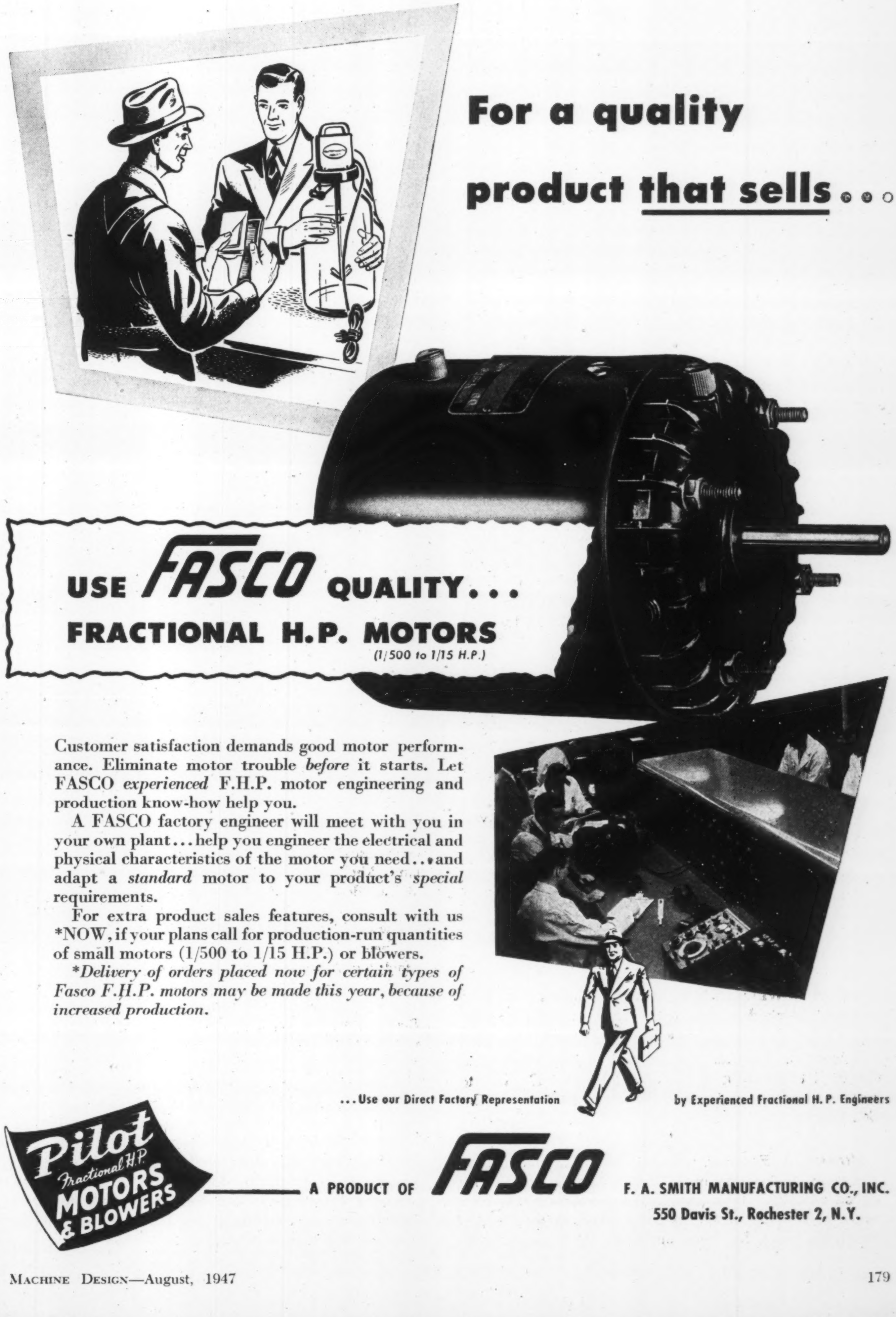
George H. Clark

DAVID C. PETERSON, former industrial consultant, is the new director of engineering and research at the main Chicago plant of Stewart-Warner Corp. For six years Mr. Peterson was actively engaged as an industrial consultant to several large diesel engine manufacturers, working on various phases of engineering and production. During the war he also served as a consultant for the Army Air Forces. Prior to his consulting work, from 1934 to 1939, he was associated with the Continental Can Co., where he was in charge of all engineering operations of the company's tin plate mills in Pittsburgh. In 1935 and 1936 he was responsible for the construction and organization of a large tin plate mill for a British subsidiary of Continental. Returning to the United States, he was placed in charge of rehabilitation of various Continental plants through the country. During the previous twenty years from 1914-1934, Mr. Peterson was with the Buda Co. His various positions included those of plant engineer, general superintendent, assistant to the vice president in charge of manufacturing, and finally in complete charge of all engineering and manufacturing operations.

Stanley Bracken

GEORGE H. CLARK, identified with many developments in the plastics field, is the new president of the Society of the Plastics Industry. Mr. Clark, who is vice president in charge of engineering of The Formica Insulation Co., Cincinnati, had been vice president of the Society prior to his recent election. Born in Maine in 1890, he graduated from the Massachusetts Institute of Technology with a mechanical engineering degree in 1913. He remained there for three years as an instructor in the department of mechanical engineering, leaving to become an experimental engineer for the Crosby Steam Gauge & Valve Co. This was followed by approximately a year and a half in the Navy Bureau of Ordnance during World War I. Following the war period he spent five years as factory superintendent of Merriman Bros., and the next two years he was with Waltham Watch Co. as an engineer in the speedometer division. In 1926 he joined Formica and has been here continuously since.

STANLEY BRACKEN, previously vice president in charge of manufacture, has been promoted to the post of executive vice president of Western Electric Co. Immediately upon graduation from the University of Nebraska in 1912, Mr. Bracken joined the Western Electric Co. He was assigned to development engineering and continued in various branches of this activity until 1922. For three years he represented the company abroad, and returned to the Hawthorne Works of the firm in 1925. In 1929 he was made assistant engineer of manufacture, and a year later when Western Electric purchased the



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A FASCO factory engineer will meet with you in your own plant . . . help you engineer the electrical and physical characteristics of the motor you need . . . and adapt a *standard* motor to your product's *special* requirements.

For extra product sales features, consult with us *NOW, if your plans call for production-run quantities of small motors (1/500 to 1/15 H.P.) or blowers.

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. . . Use our Direct Factory Representation by Experienced Fractional H. P. Engineers

Pilot Fractional H.P. **MOTORS & BLOWERS** — A PRODUCT OF **FASCO**

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550 Davis St., Rochester 2, N.Y.

Teletype Corp., he was named executive vice president and director of that company. In 1937 he became president of the new corporation, and in 1939 engineer of manufacture of Western Electric. He resigned as president of the Teletype organization in 1941, to assume his post as a director of Western Electric and general manager of manufacture. A year later he was elected vice president of Western Electric, where he remained until his present promotion.

◆

Eric J. Young, active in the electronic and mechanical fields in England, Iraq, Palestine and Venezuela for more than twenty years, has joined Production Methods Inc. as senior design engineer. His most recent position prior to his appointment was that with S. S. White Dental Mfg. Co. where he had been engaged on design and research engineering.

◆

R. R. Hutchinson has been promoted to assistant chief engineer of Pontiac Motor Division in charge of current engineering and new projects. Mr. Hutchinson was motor engineer for the first Pontiac produced.

◆

Paul Huber, formerly assistant director of the General Motors proving grounds at Milford, Mich., has been named director of research. Other appointments by the company include those of **Charles Cuma**, engine development; **E. C. Desmet**, assistant to the vice president in charge of engineering; **Joe H. Talley**, general manager of the aircraft and research division; **Robert E. Busey**, in charge of truck engineering; **Walter F. Benning** in charge of passenger car engineering and technical assistant to **Delmar G. Roos**, director of engineering; **F. L. Mills**, chief draftsman of the chassis division; and **D. D. Stone**, research engineer.

◆

Joseph M. Gwinn Jr. has joined the hoist and body division of Gar Wood Industries, Wayne, Mich. as chief engineer. He had been associated as division manager with Consolidated Vultee Aircraft Corp., Nashville, Tenn.

◆

S. J. Steven, formerly associated with Republic Aviation Corp., has become assistant chief mechanical engineer at Pioneer Gen-E-Motor Corp., Chicago.

◆

Everett M. Sandahl prior to taking his present position as design engineer with International Harvester Co., Chicago, had been employed with Torrington Co., bearings division.

◆

Lester E. Wetzler is the new assistant chief engineer at James Cunningham Sons & Co., Rochester, N. Y.

◆

Robert C. Wallace has resigned as vice president in charge of engineering of Marmon-Herrington Co. Inc. to become executive engineer of the Diamond T Motor Car Co., Chicago.

◆

Howard A. Flogaus, who had been vice president in charge of engineering of ACF-Brill Motors Co. has resigned recently. **William E. Williams**, who has been active in the field of automotive engineering for the past twenty-six years, has been appointed development engineer of the company. **Frank A. Kately** continues as chief engineer of ACF-Brill Motors Co.

◆

Edward B. Douglas, chief engineer at Douglas Engineering Co., Lincoln Park, N. J., has been advanced to president.

◆

John W. Oehrli is consulting engineer with the Salisbury Motors Inc., subsidiary of Northrop Aircraft Inc., Pomona, Calif., and will devote his efforts to the development of small engines for automotive and industrial service. Mr. Oehrli had been an engineer with McCulloch Aviation.

◆

Harris C. Hug recently has been advanced from lead engineer to design engineer of research at Boeing Aircraft Co., Seattle.

◆

John H. Allmand has joined Gar Wood Industries Inc. at the Wayne, Mich. plant as designer and senior layout man in the winch and crane division. He had formerly been associated with Graham-Paige Motors Corp.

◆

John V. Bassett has been promoted from senior automotive engineer to chief engineer of heavy-duty friction materials for Raybestos-Manhattan Inc., Passaic, N. J.

◆

James E. Wasem Jr., a test engineer formerly connected with General Electric Co., has become associated with the University of Delaware, Newark, Del., as instructor in their department of mechanical engineering.

◆

Jerry M. Gruitch, who had been assistant chief engineer at the Dodge division of Chrysler Corp., in Detroit, has been named vice president in charge of engineering at the O. A. Sutton Corp., Wichita, Kans.

◆

C. L. Cummins, president and **H. L. Knudsen**, vice president in charge of engineering at Cummins Engine Co. Inc., Columbus, Ind., were recently awarded gold pins in recognition of twenty-five years' faithful service to the company.

◆

A. P. Fontaine has joined, as director, the Aeronautical Research Center of the University of Michigan, Ypsilanti, Mich. He relinquished his position as director of aircraft development, Bendix Aviation Corp., Detroit.

◆

George N. Sieger, president of S-M-S Corp., Detroit, has been elected president of the Resistance Welder Manufacturers Association at their recent meeting.

◆

Loren J. James has resigned as design engineer for Beech Aircraft Corp., Wichita, Kans., to become a partner in the Moran Truck & Tractor Co., Moran, Kans.

◆

Lyndon C. Cole, whose appointment as chief engineer of the Machine Division of The Osborn Manufacturing Co., Cleveland, was announced in the June issue of Machine Design, was formerly chief engineer of the temporary Cleveland engineering office of the Hydraulic Press Mfg. Co., Mt. Gilead, O., and not chief engineer in charge of the company's main engineering department and activities as may have been inferred from the previous announcement.

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IN ANY APPLICATION where studs are used, "LOK-THRED" Studs will lock more securely and prove stronger in both tension and torsion than American National Threads.

The "LOK-THRED" design avoids the chief weakness of ordinary interference fit, which places the metal of the receiving thread under shear and thus tends to cause a bursting or splitting action.

Note these other important advantages of "LOK-THRED" which are explained fully in the new booklet pictured here:

1. **Modified American National Thread permits use of standard tools. (Page 6.)**
2. **Does not require selective fits. (Page 6.)**
3. **Locks securely and becomes tighter in service. (Page 9.)**
4. **Carries entire normal working load on 6° angle at root of thread under high compressive prestress. (Page 11.)**
5. **Does not gall when being driven nor fret in service. (Page 12.)**
6. **Stronger in both tension and torsion than ordinary American National Threads. (Page 12.)**
7. **Has much higher fatigue limits than studs with conventional threads. (Page 13.)**
8. **Acts as dowels and taper pins. (Page 16.)**
9. **Seals positively and eliminates added bosses and blind tapping. (Page 17.)**
10. **Re-usable and on any re-application less than one-half additional turn brings torque back to its original installation value. (Page 17.)**

Write for "LOK-THRED" Booklet for full information.

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BUSINESS AND SALES BRIEFS

WIRE PRODUCTION facilities have been expanded in the Bristol, R. I., plant of United States Rubber Co. through the purchase of more than a million dollars worth of rubber and plastic insulating equipment from the government and other sources. It is expected that the additional facilities will increase the plant's capaciy to three times the prewar output.

◆

Previously executive vice president, Tom J. Smith Jr. has been elected president of Pressed Metal Institute, Cleveland.

◆

Wiley-Hughes Supply Co. Inc., Spruce St. & New York Ave., Trenton 8, N. J., has been named by Carboloy Co. Inc. to serve as an authorized distributor in Trenton and throughout central New Jersey. C. E. Coleman, sales manager of Wiley-Hughes, will head the new Carboloy operation.

◆

Among other appointments recently announced by Nelson Electric Corp., Santa Monica, Calif., are the following: George Otis, vice president and director; and Jack D. Phelan, sales manager and director.

◆

Henceforth Sage Equipment Co. will be located at 30 Essex St., Buffalo 13. Larger quarters have increased facilities for production of a full line of casters, hand trucks, gravity wheel conveyors and portable power boosters.

◆

A working agreement has been completed by Jessop Steel Co., Washington, Pa., and Alan Wood Steel Co., Conshohocken, Pa., whereby the technical and manufacturing facilities of both companies will be used for large tonnage production of stainless-clad steel sheets.

◆

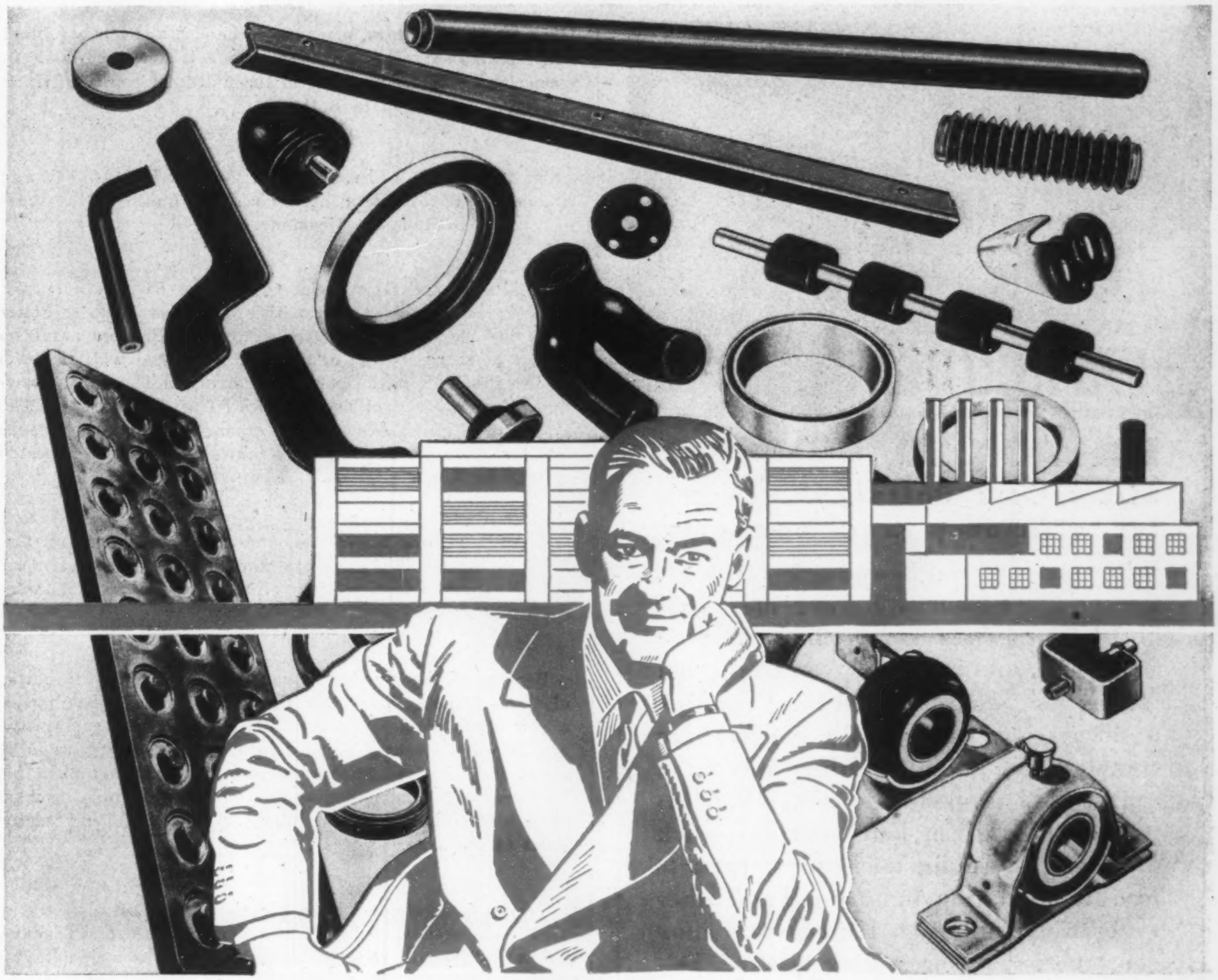
Harold A. Hintz has been promoted to Pacific Coast sales manager of H. K. Porter Co. Inc., with headquarters in the Petroleum Bldg., Los Angeles. He will direct the activities of all Porter sales offices on the Pacific Coast. Also announced is the appointment of J. F. Morley as district sales engineer, with offices in the Monadnock Bldg., 681 Market St., San Francisco 5.

◆

Formerly president of the Pacific Chemical Co., Alfred T. Alden has been appointed general sales manager of Ellinwood Industries, Los Angeles. Reporting directly to him will be the sales managers of the farm equipment, engine, and electronics divisions throughout the country.

◆

Two newly formed sections will handle the electronics engineering and electronics sales activities of the Buffalo divisions of Westinghouse Electric Corp. E. H. Vedder has been appointed manager of the electronic control engineering section and R. W. Staggs, manager of the electronic control sales section. Mr. Staggs also will be responsible for sales activities of resistance welding control. C. B. Stadum has been named manager of the resistance welding engineering sec-



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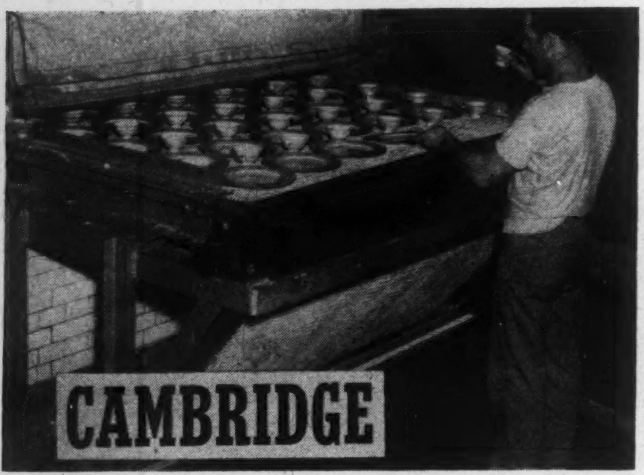
THE OHIO RUBBER COMPANY · WILLOUGHBY, OHIO



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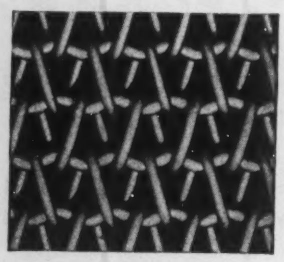
Wherever material handling is required, Cambridge Balanced Belting makes all pottery processes more efficient, more economical. As in the above installation for carrying quality china ware through a decorating kiln, costly saggers are completely eliminated—thus solving a century-old problem of storage and expense. Open mesh belt provides quick drying on washing operations; permits free air circulation on infra-red and other types of drying. High temperature alloy construction assures long life of belt under kiln temperatures. For full details, write Dept. 21.



Close-up showing alternate spiral construction and crimped wire connection of Cambridge Balanced Belting.

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tion and W. G. Roman, manager of the electronic section. Both will report to Mr. Vedder. These changes have been made in connection with the transfer of the industrial control division from East Pittsburgh to Buffalo.

◆

Michigan Tool Co. has appointed Vittetow Inc., 1439 Detroit St., Denver 6, to serve as exclusive representative in the states of Colorado, Utah and Wyoming.

◆

Local sales and sales engineering offices have been opened by Progressive Welder Co. at 578 Maccabees Bldg. to better serve the Detroit metropolitan area. Harry S. Rose has been placed in charge of the new office. Associated with him will be Douglas K. Renny, Douglas I. Harris and Thomas J. Crawford. Formerly the office was located at the plant at 3050 East Outer Drive but rapidly expanding use of resistance welding processes in Detroit metalworking industries created a need for larger quarters.

◆

According to a recent announcement by The Buda Co., Fred W. Sparks has joined the organization as district representative to handle the Ohio territory for the manufacturer's engine division.

◆

Because of the growing demand of Illinois industry, particularly in Macon County, Air Reduction Sales Co. has opened a new oxgen plant at Decatur, Ill. The plant will supply oxygen to points formerly serviced by the company's plants in St. Louis and Chicago. Another oxygen manufacturing plant has been opened at Baton Rouge, La., which will supply demands of Louisiana industry, particularly in the south and central parts of the state.

◆

Previously in charge of the Cleveland sales office, Harry M. Dexter has been named sales manager of Continental-Diamond Fibre Co. He will transfer his activities to the main office in Newark, Del.

◆

Appointment of Joseph M. Weldon as assistant to the vice president has been announced by The International Nickel Co. Inc. He will serve as an assistant to H. J. French, vice president. Prior to his appointment Mr. Weldon was head of the aeronautical division of the INCO nickel alloys sales department.

◆

With headquarters at the district office in Chicago, Theodore E. Burke has joined the Vanadium Corp. of America as sales engineer in the railroad division. Previously he was associated with Youngstown Sheet & Tube Co. and Republic Steel Corp.

◆

H. D. Foster has succeeded the late W. C. Winings as manager of the mechanical goods division of Goodyear Tire & Rubber Co., Akron, O. Sam DuPree will act as assistant manager of the division. Prior to his appointment Mr. Foster served as eastern sales manager of the division. He has been succeeded by O. A. Schilling, who will make his headquarters in Akron.

◆

Recent additions to the sales organization have been announced by Leach Relay Co., Los Angeles. They are: Industrial & Communications Equipment Co., 1707 Grand Central Ave., Tampa 6, Fla.; H. A. Chamberlin, 31 Milk St., Boston; Campion Sales Co., Republic National Life Bldg., Dallas, Tex.; Fred B. Hill, 256 First Ave. North, Minneapolis; H. A. Roes

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Versatile Lamicoid *is used for many moving parts, structural elements and electrical insulation in Marchant Calculators where dependable performance counts.*

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Gears made from Lamicoid run smoothly and quietly, and provide the wear and abrasion resistance necessary for long, trouble-free life. This material is easily machined to precision tolerances, and holds its shape and accurate dimensions under hard usage.

Lamicoid is available in a variety of fabric and paper bases laminated with selected thermosetting resins. It has high electrical and mechanical strength, is highly resistant to moisture, oils, and dilute acids. It is light and offers strength without bulk. Consult our technical representative for full details about Lamicoid.

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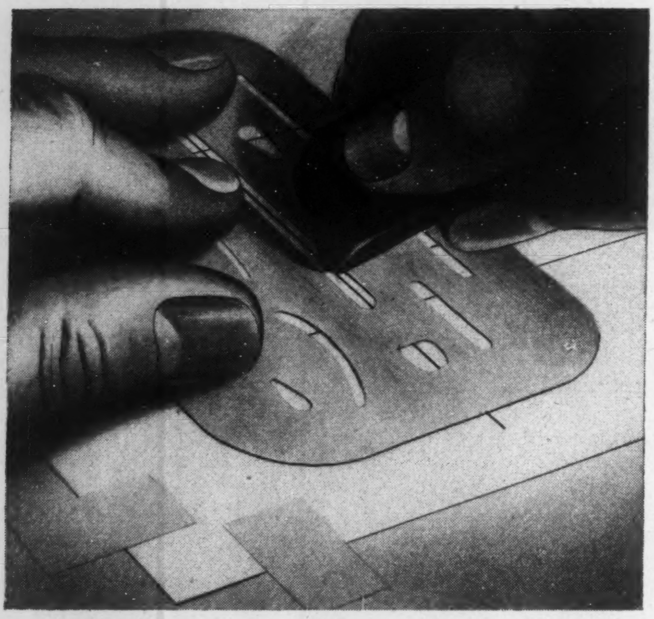
St. Louis • San Francisco • FABRICATORS: Lamicoid Fabricators, Inc., Chicago, Illinois • Bakoring, Inc., Houston, Texas • Insulating Fabricators Inc.,
New York City • Insulating Fabricators of New England, Inc., Watertown, Mass.



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AMERICA'S STANDARD FOR OVER 20 YEARS

& Co., 1805 Grand Ave., Kansas City 8, Mo.; Ralph M. Hill and Gordon E. Gray, 1 North Crawford Ave., Chicago 24; Leslie M. Devoe Co., 4014 Washington Blvd., Indianapolis 5; W. F. Seaman, 248 Delaware Ave., Buffalo; Samuel K. MacDonald, 1531 Spruce St., Philadelphia 2; and O. F. Masin, 17 East 42nd St., New York 17.

◆

Henceforth the Detroit district office of The Emerson Electric Mfg. Co. will be located at 1375 East Jefferson Ave. O. D. Metz is district manager.

◆

Connected with Tennessee Enamel Mfg. Co. for the past eighteen years as executive vice president, Robert G. Calton has joined the sales staff of Chicago Vitreous Enamel Product Co., Cicero 50, Ill. He will work with enameling plants in the southern territory. Wesley L. Dinsmore has joined the company as sales engineer, formerly having been superintendent of the porcelain enamel department of General Electric Co.

◆

A district sales office has been opened by The Thomas Steel Co. at 20 Pine St., Room 2308, New York. Hugh J. Smith has been placed in charge.

◆

Koppers Co. Inc., has appointed John A. Worthington as general sales manager of the piston ring division at Baltimore, Md. T. Latimer Ford will head a new company department devoted exclusively to replacement sales.

◆

An office has been established by Salem Engineering Co. at 512 Sinclair Bldg., Ft. Worth, Tex. The office has complete technical engineering and construction facilities for planning and building industrial furnaces of all types. Harris Pruitt will be in charge of all the company's activities in this territory. Before the war and since December, 1945, he has directed company sales efforts throughout the Southwest.

◆

F. W. Mesinger, vice president, has been elected to the board of directors of Norma-Hoffmann Bearings Corp. He has been with the corporation for twenty-eight years and is in charge of sales.

MEETINGS AND EXPOSITIONS

Aug. 21-22—

Society of Automotive Engineers Inc. West Coast transportation and maintenance meeting to be held at Biltmore Hotel, Los Angeles. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

Sept. 1-4—

American Society of Mechanical Engineers. Fall meeting to be held at Hotel Utah, Salt Lake City, Utah. C. E. Davies, 29 West 39th St., New York 18, is secretary.

Sept. 8-9—

American Society of Mechanical Engineers. Second national conference of industrial instruments and regulators division to be held at Chicago. Additional information may be obtained from headquarters of the society

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15.000" x 19.000" x 2.000"
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help SUPER JUICER squeeze 480 OPM*

*Oranges per minute

KAYDON Bearings play a very important part, say the designers, in this remarkable machine, so aptly christened the FMC SUPER JUICER. **KAYDON** precision radial bearings support the entire revolving head, including the actuating cam and upper cups of the squeezing mechanism, the head traveling smoothly, 24 revolutions per minute.

SUPER JUICER is *right!* Produces upwards of 300 gallons of juice per hour. It's super *juice*, too . . . tastes fresher, keeps better . . . since the juicing operation keeps the juice from the inside of the citrus fruits from mixing with the oil from the rind.

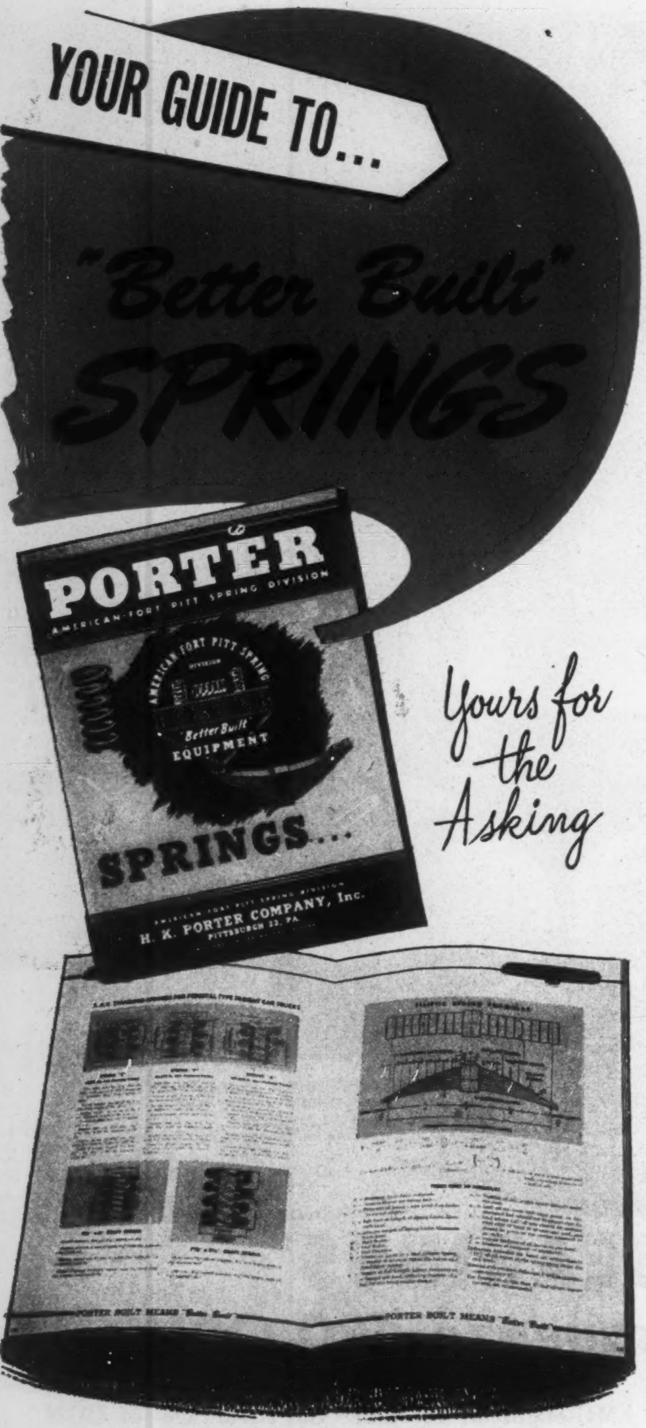
FMC engineers recognize the advantages of **KAYDON** precision bearings, just as designers of many other types of heavy-duty machinery do, in such widely varied fields as oil field machinery, rock-crushers, grinders, steel mills and paper mills, road equipment, excavators, hoists, bending machines and other heavy-duty equipment.

For sound bearing-cooperation, contact **KAYDON.**

KAYDON *Types of Standard or Special Bearings:*
Spherical Roller • Taper Roller
Ball Radial • Ball Thrust
Roller Radial • Roller Thrust

THE KAYDON ENGINEERING CORP.
MUSKEGON • MICHIGAN

All types of Ball and Roller Bearings 4" bore to 120" outside diameter



Here in this 28-page engineering catalog you will find everything you need to know about spring specifications: 28 fact-filled pages containing all the data necessary to specify springs for any purpose—formulas, graphs, charts, tables and illustrations for all types of springs from light wire to heavy elliptic. Write today for your copy of Catalog 306.

H. K. PORTER COMPANY, Inc.
AMERICAN-FORT PITT SPRING DIVISION
PITTSBURGH 22, PENNSYLVANIA
District Offices in Principal Cities

at 29 West 39th St., New York 18. C. Davies is secretary.

Sept. 8-12—

Instrument Society of America. Second annual instrument conference and exhibit to be held at Stevens Hotel, Chicago. Richard Rimbach, 1117 Wolfendale St., Pittsburgh 12, is executive secretary.

Sept. 17-18—

Society of Automotive Engineers Inc. Tractor meeting to be held at Hotel Schroeder, Milwaukee. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

Sept. 17-26—

National Machine Tool Builders' Association. Machine tool show and congress to be held at Dodge-Chicago plant of the Tucker Corp., Chicago. Tell Berna, 10525 Carnegie Ave., Cleveland 6, is general manager of the association.

Oct. 2-4—

Society of Automotive Engineers Inc. Aeronautic (fall) meeting and aircraft engineering display to be held at Biltmore Hotel, Los Angeles. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

Oct. 6-7—

Packaging Machinery Manufacturers Institute. Fifteenth annual meeting to be held at Hotel Sheraton, Springfield, Mass. H. L. Stratton, 342 Madison Ave., New York 17, is secretary.

Oct. 6-8—

American Society of Mechanical Engineers. Petroleum mechanical engineering conference to be held at Houston, Tex. Additional information may be obtained from headquarters of the society at 29 West 39th St., New York 18. C. E. Davies is secretary.

Oct. 18-24—

National Metal Exposition to be held at International Amphitheatre, Chicago. Chester L. Wells, 7301 Euclid Ave., Cleveland 3, is assistant managing director of the exposition.

Oct. 20-21—

Society of Automotive Engineers Inc. Production meeting to be held at Carter Hotel, Cleveland. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

Oct. 20-22—

American Society of Mechanical Engineers. Joint meeting of the fuels division with the coal division of the American Institute of Mining and Metallurgical Engineers to be held at Cincinnati, O. Additional information may be obtained from ASME headquarters at 29 West 39th St., New York 18. C. E. Davies is secretary of ASME.

Oct. 20-23—

American Institute of Mining and Metallurgical Engineers. Annual fall meeting of the iron and steel division and the institute of metals division to be held at Stevens Hotel, Chicago, in conjunction with the National Metal Exposition. Ernest Kirkendall, 29 West 39th St., New York 18, is secretary of the institute.

Oct. 20-24—

American Society for Metals. Annual meeting to be held at Palmer House, Chicago, in conjunction with the National Metal Exposition. W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, is secretary of the society.

Oct. 20-24—

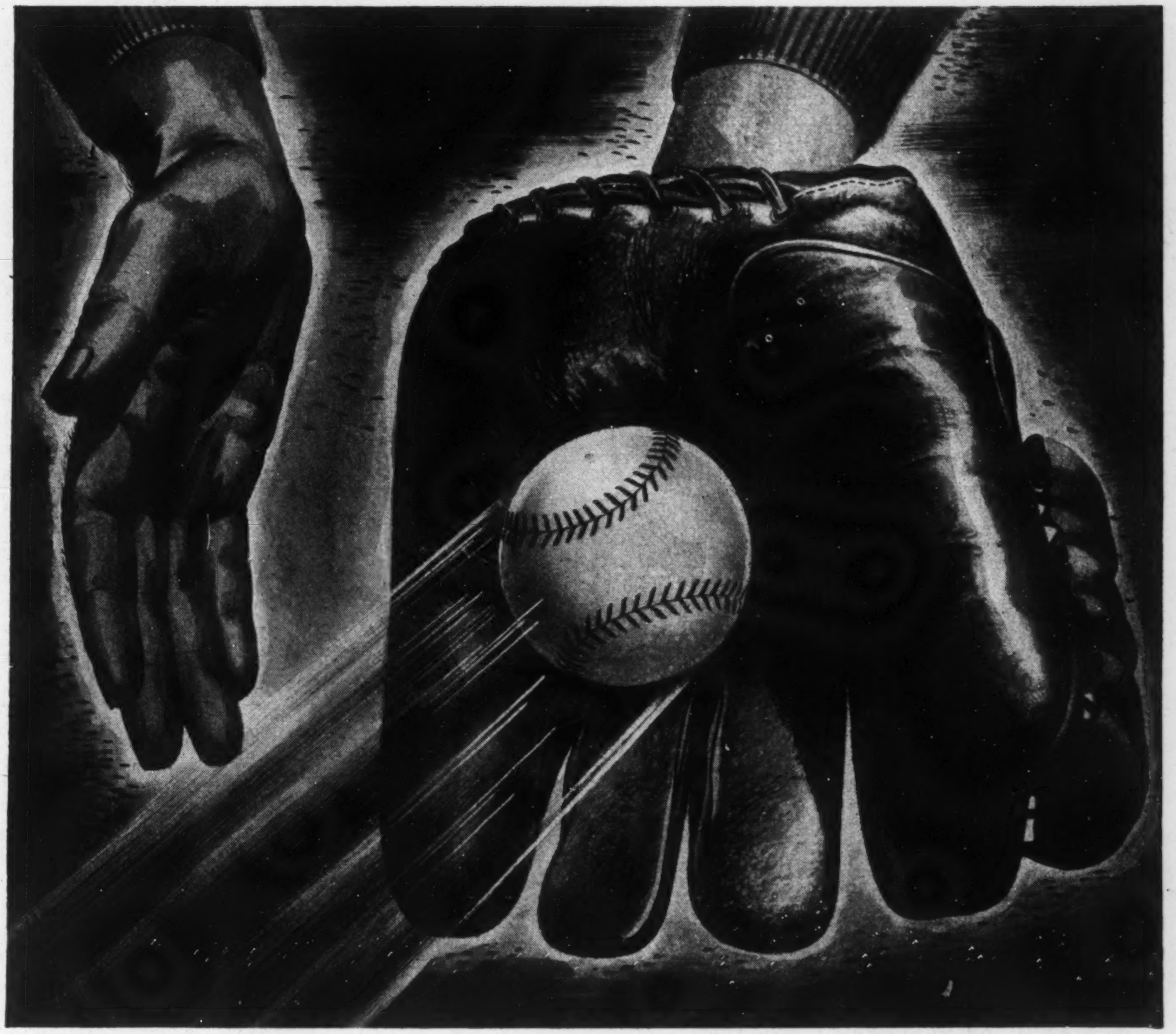
American Welding Society. Annual meeting to be held at Sherman Hotel, Chicago, in conjunction with the National Metal Exposition. M. M. Kelly, 33 West 39th St., New York 18, is secretary of the society.

Oct. 20-24—

American Industrial Radium and X-Ray Society. Annual meeting to be held at Continental Hotel, Chicago, in conjunction with the National Metal Exposition. Philip D. Johnson, 53 West Jackson Blvd., Chicago 4, is secretary of the society.

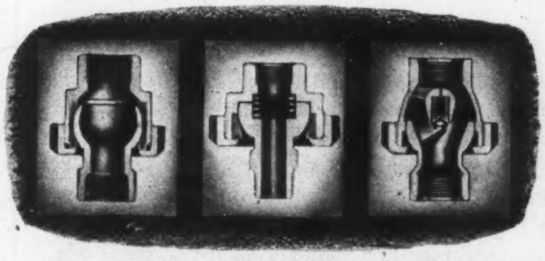
Oct. 30-Nov. 1—

American Society of Tool Engineers. Fifteenth semiannual meeting to be held at Statler Hotel, Boston. Harry E. Conrad, 1666 Penobscot Bldg., Detroit 26, is executive secretary.



TO ABSORB SHOCK

—Fuel Lines need Barco Flexible Joints



The battering impacts and shocks of vibration in mechanical operation are absorbed by Barco Flexible Joints. Providing for expansion and contraction, they keep pipes aligned, protect fluid-conveying systems against interruptions or breakdowns. In every branch of industry and transportation you will find Barco Joints at work, giving fuel line systems longer life, insuring steadier and more economical operation. Full details on request. Barco Manufacturing Company, Not Inc., 1806 Winnemac Avenue, Chicago 40, Illinois.

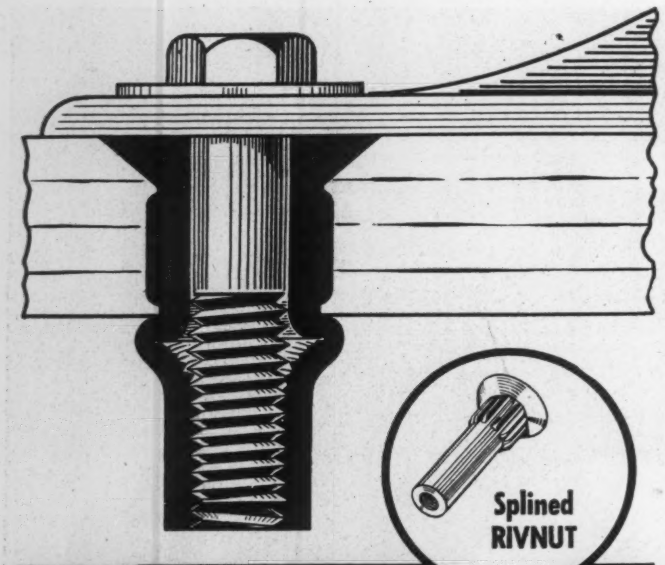
BARCO FLEXIBLE JOINTS

Not just a swivel joint . . . but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

In Canada: The Holden Co., Ltd., Montreal, Canada.

"MOVE IN EVERY DIRECTION"



New way to fasten seats solves assembly problem

Bus designers ran up against a tough assembly problem in attaching seats to plywood floorboards. The under side was not accessible. Conventional bolts, nuts and lock washers wouldn't work. But they found the perfect answer in a splined B. F. Goodrich Rivnut!

Using a pneumatic heading tool, one man did the job from *one side* of the work only. A strong, tight-gripping bulge was formed in the Rivnut, preventing pull-through. The Rivnut's splined shaft took care of torque. And the still intact Rivnut threads provided a deep nut plate for secure, vibration-resistant attachment of the bus seat. Many man-hours were saved.

Perhaps Rivnuts will improve your product, reduce assembly time—or *both!* Why not consult a Rivnut engineer? Write The B. F. Goodrich Company, Dept. MD-87, Akron, Ohio.

READ HOW RIVNUTS SIMPLIFY DESIGN in new "Rivnut Data Book"

Here's the new edition, 40 pages packed with fastening facts. Fully illustrated, including step-by-step drawings of Rivnut installation. Lists types, sizes, load capacities, successful applications. For your free copy, write to The B. F. Goodrich Company, Dept. MD-87, Akron, Ohio.

Rivnut
DATA BOOK

B.F. Goodrich

RIVNUTS

It's a rivet—It's a nutplate

Design Trends

(*Concluded from Page* 113)

chrome strips or the other recent fads. From a long-term or historical viewpoint this might be considered as descriptive of our present position.

Superimposed on this broad general movement are many short-term trends the more important of which have been summed up previously. These short trends are definitely influenced and often caused by factors such as wartime restrictions, economic considerations, new materials, new techniques, a contemporary trend in art or architecture, and perhaps most frequently by a radical change in the design treatment of a particularly outstanding project by some prominent designer. The style factor cannot be minimized in importance as it affects sales, but it is a fickle one reflecting both the everchanging economic conditions and public taste.

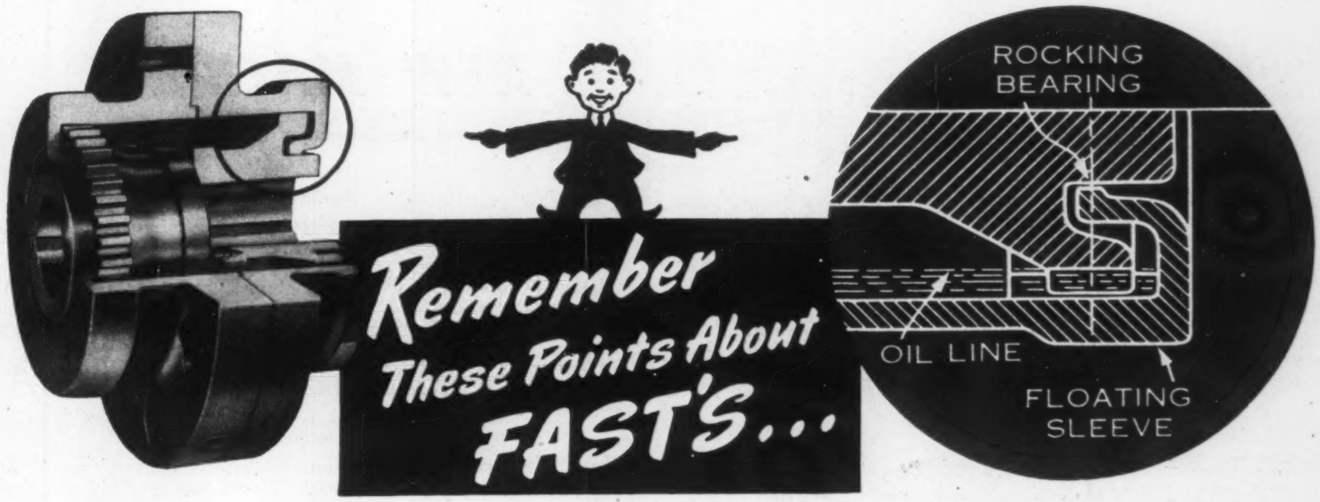
On a long-term basis good design will be judged by the consumer with respect to utility, cost and appearance. There is little doubt that the best designs of tomorrow will be those in which pure utility plays a primary part in the development of the basic form, *Fig.* 10, with the aesthetic factors also given careful consideration.

Final Design a Compromise

Each design is a new challenge to the designer whether it is the development of a new invention or merely the redesigning of an existing machine. Although a design must evolve from a series of compromises and the final result is only an approach to a theoretical ideal, the good designer must always try to visualize this ideal so that he may properly evaluate all considerations. The designer must keep well abreast of advances being made in all fields of science and engineering which are of value to him as a designer. He must appreciate the many factors involved in manufacturing costs, distribution costs and the general economic trend. To be really successful he must have a definite aptitude for the aesthetic side of design, a thorough fundamental training in basic design, and a knowledge of current public taste. Above all he must be able to approach logically any new problem, organize his work, be able to distinguish between the essential and the irrelevant and proceed directly toward his original objective.

A few industrial designers have voiced the opinion that an engineer will never be a good industrial designer. Needless to say this statement is too all-inclusive. Without certain aptitudes and abilities the engineer will never make a good designer just as the artist who lacks certain other aptitudes and abilities will never make a good designer. It is a grave mistake to believe that a man with any kind of a natural talent or engineering background can, by reading or part-time study, achieve the breadth of training he will need to compete successfully with tomorrow's well trained industrial designer. Intensive study under close supervision and intimate contact with industry are both necessary to develop an individual's critical ability and philosophy of design to the point of competence.

In a subsequent article the fundamental concepts of design for improved appearance will be discussed.



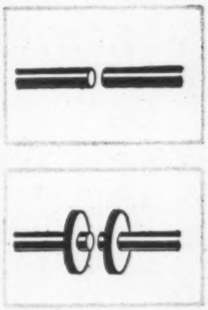
and you can Forget about Coupling Shutdowns

Exclusive Metal-to-Metal Seal Gives You *Extra* Protection

The surest way to stop coupling shutdown worries is to install Fast's Couplings in your plant. For one thing, the *exclusive* "rocking bearing" shown above makes a positive metal-to-metal seal for the load-carrying oil . . . permanently protecting it against wear-producing moisture, dust and grit. No perishable packing rings are used. There's nothing to wear, nothing to fail. The coupling is all-steel throughout—without a single perishable part.

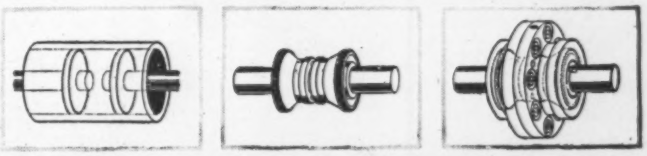
Remember: Fast's self-aligning Couplings are the *original* gear-type couplings. Years of design and manufacturing experience go into every one . . . to give you uninterrupted power transmission . . . to lengthen machine life, lower upkeep costs, minimize shutdown losses.

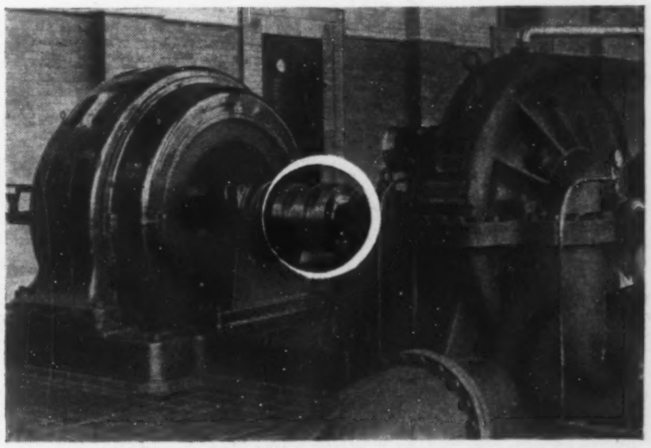
We have a full complete line of couplings for immediate delivery. Get full details on Fast's Couplings now. Write today for your free copy of our complete catalog. Address: Koppers Company, Inc., Fast's Coupling Dept., 258 Scott Street, Baltimore 3, Md.



Fast's Couplings Are Simple as A-B-C

See the simple development of Fast's Couplings. A splined hub on each shaft end, a sleeve with internal splines to mesh. Oil in the sleeve carries the load between the splines.

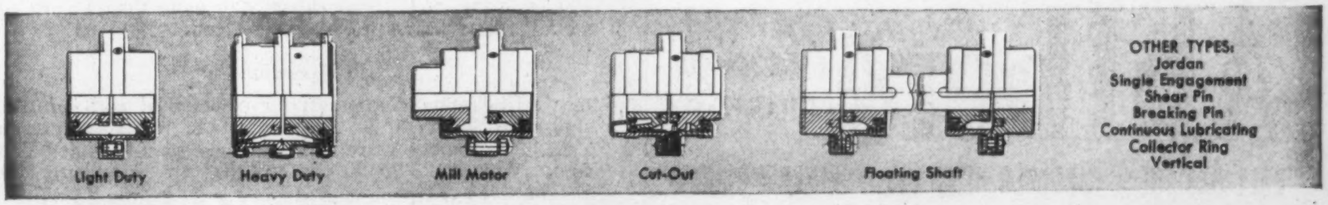




THIS NO. 6 FAST'S COUPLING connects an 1800 h.p., 600 r.p.m. motor to a 30 million gallon (per 24 hrs.) pump at the City of Montreal Pumping Station.

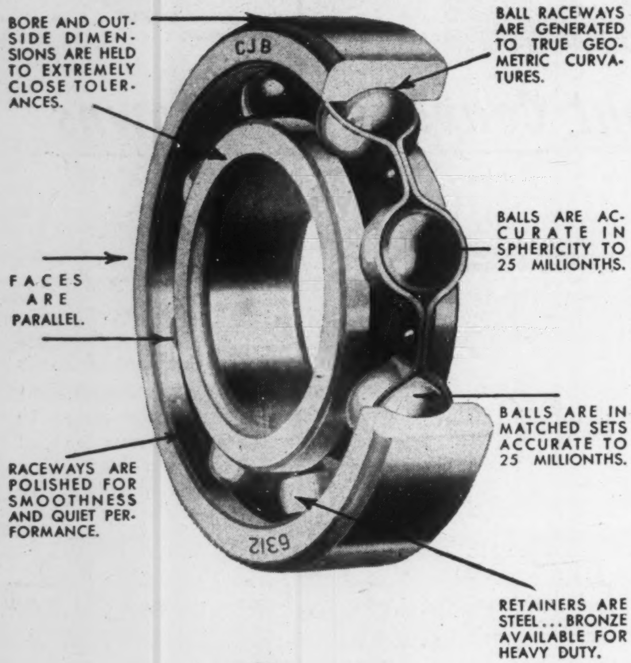
K KOPPERS

FAST'S
self-aligning
COUPLINGS



OTHER TYPES:
Jordan
Single Engagement
Shear Pin
Breaking Pin
Continuous Lubricating
Collector Ring
Vertical

HERE'S WHY—
CJB AHLBERG
BALL BEARINGS
*Run Smoothly • Quietly
with Long Life*


BORE AND OUTSIDE DIMENSIONS ARE HELD TO EXTREMELY CLOSE TOLERANCES.
BALL RACEWAYS ARE GENERATED TO TRUE GEOMETRIC CURVATURES.
BALLS ARE ACCURATE IN SPHERICITY TO 25 MILLIONTHS.
FACES ARE PARALLEL.
BALLS ARE IN MATCHED SETS ACCURATE TO 25 MILLIONTHS.
RACEWAYS ARE POLISHED FOR SMOOTHNESS AND QUIET PERFORMANCE.
RETAINERS ARE STEEL... BRONZE AVAILABLE FOR HEAVY DUTY.
CJB
6312

CJB Ahlberg Ball Bearings are precision assemblies of these quality components, engineered and manufactured for top performance. Ahlberg Bearing Company, 3017 West 47th Street, Chicago 32, Illinois.

Ahlberg Bearings CHICAGO
BALL BEARINGS • ROLLER BEARINGS • PILLOW BLOCKS

NEW MACHINES

And the Companies Behind Them

Agriculture

Two-wheeled, rubber-tired tractor-scraper. Tractor equipped with 225 hp diesel of positive forced ejection type. La Plant-Choate Mfg. Co., Cedar Rapids, Ia.

Hydraulic seedling planting machine. Averages 10,000 seedlings in eight hours. Drawn by conventional tractor, and requires crew of three. Lowther Mfg. Co., Winona, Wis.

Tractor with new drawbar height control mechanism, and an improved hydraulic system and linkage attachment for implements. Has four forward speeds. Ford Motor Co., Detroit.

Domestic

Radio-phonograph combination featuring "lift-out" radio and ample record storage space. Westinghouse Electric Corp., Sunbury, Pa.

Low-priced kitchen clock which fits flush against wall, in plastic; also two mantel clocks—one a nautical design which strikes time on the hour and half hour; while the other, a Colonial reproduction, has deep-toned spiral gong striking the hours and half hours. General Electric Co., Bridgeport 2, Conn.

Gas-fired forced air furnace, for average home where ducts are used for warm air distribution. Palmer Mfg. Corp., Phoenix, Ariz.

Electric "Singette" for singeing, basting, etc. Also useful for removing paint, quick defrosting of refrigerator coils, thawing frozen pipes, etc. Henry J. Morton Associates Inc., Detroit 19.

Metalworking

Special contour forming machines for making a variety of products ranging from small metal cabinets to the major parts in railroad cars and transport planes. The Cyril Bath Co., Cleveland 8.

All-hydraulic inclinable press. Capable of up to 115 strokes per min. Pressure capacity up to 50 tons. Hydraulic Press Mfg. Co., Mt. Gilead, O.

Horizontal hydraulic bulldozer, 400-ton model welded steel has high operating variable speed. Stroke: 24 in. Beatty Machine & Mfg. Co., Hammond, Ind.

Horizontal metal-cutting band saw, heavy-duty, features an automatic cutting cycle for rectangular stock up to 12 in. wide or cylindrical stock up to 12 3/4 in. diam. Wells Mfg. Corp., Three Rivers, Mich.

Double-cylinder hydraulic broaching machine, 36-in. stroke. Pulling power equals 16,000 lb. Zagar Tool Inc., Cleveland 17.

Adjustable multiple spindle work head. Available in models having from two to twelve spindles individually adjustable from 1/2-in. minimum to 12 in. maximum center distance. International Research Corp., Los Angeles 23.

Mining

Two diesel engines and two track-type tractors and two motor graders powered by these engines, which are 4 and 6-cylinder types, Caterpillar Tractor Co., Peoria, Ill.

Air-cooled, portable compressors. Models in 60, 105, 160, 210 and 315 cfm, V-type cylinder design. Davey Compressor Co., Kent, O.

Plastics

Electronic sealer for "one-shot" bonding of thermoplastic fabrics. Can be adjusted to produce any shape of seal. Seals from 7 to 15 in. in area in four seconds. Radio Corp. of America, Camden, N. J.

Refractory

Gun for application of air emplaced refractories to vertical or semivertical furnace or brick walls. Equipped with pressure hopper designed to hold 500 lb of refractory weighing 140 lb to the cu ft. Has capacity of more than 100 lb per min. Basic Refractories Inc., Cleveland.

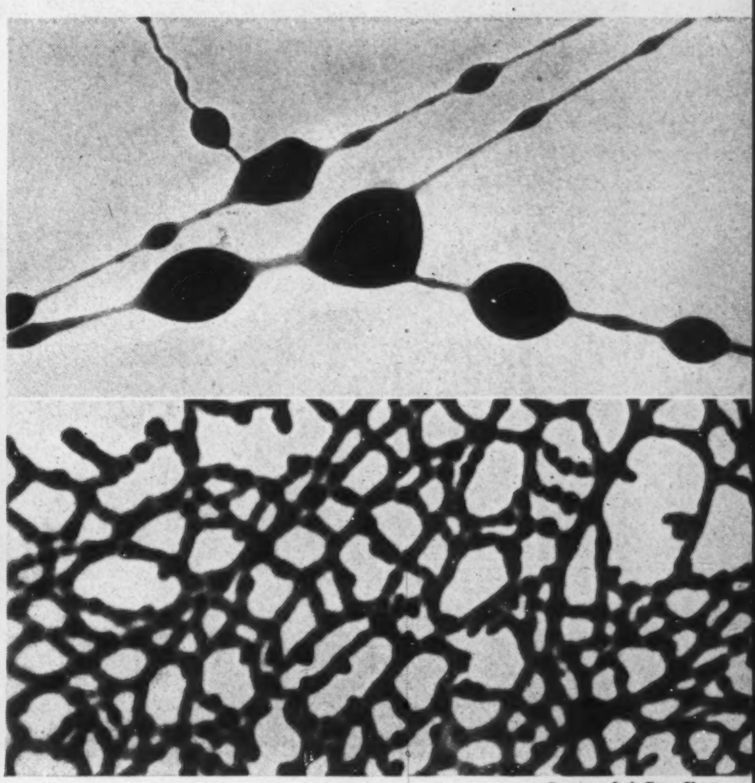
Refrigeration

Rotary refrigeration mechanism for commercial and industrial application. Weight 85 lb. Consists of rotary compressor, a motor assembly housed in a single steel cylinder shaft case. Weight, 25 to 50 per cent lighter. Frigidaire Div., General Motors Corp., Dayton 1.

For detailed information

— on products and processes

Cast iron from crane wheel magnified 2,000 times.



Courtesy *Ind. Eng. Chem.*

Above, fresh milled rubber. Below, after vulcanization. Magnifications 100,000 times.

Turn to...

photomicrography for magnifications up to 2,000 times

electron micrography for magnifications up to 100,000 times

IN many production problems, the smaller the details you can see, the more you realize their importance. It's the detail seen in a photomicrograph or an electron micrograph that often explains why some materials do their job and others don't.

Photomicrography with optical equipment reaches its useful magnification limit at about 2,000 diameters. Photographic plates from electron microscopes yield detailed information by enlargement up to 100,000 times actual size.

The problem is not whether optical or electronic magnification is better, but which is more suited to your particular requirements. Vital to the application of both in industry is photography... with its endless capacity for details... its way of making a point for all to see and be convinced.

Is your plant taking full advantage of the product-improving, cost-saving potentialities of micrography?

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

Micrography ... another important function of photography

Kodak

HYDRON SHAFT SEALS

Accurately Engineered to Each Application

To insure satisfactory performance, the design of every HYDRON Bellows Shaft Seal is determined by the requirements of the specific application. Whether the seal is for a compressor, gear box, torque converter, refrigerator, automotive fluid drive or other equipment—every condition must be carefully considered: shaft speed . . . working temperatures and pressures . . . vibration . . . space the seal will occupy, etc.

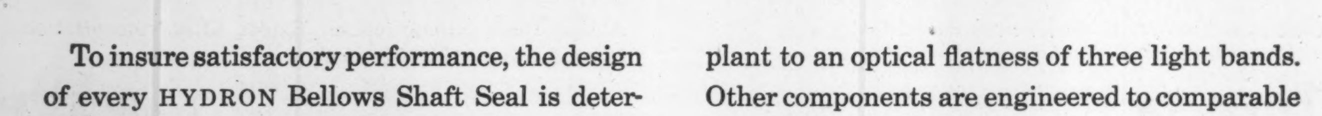
We are equipped to satisfy such requirements. For instance, the seal nose bearing surfaces for automotive fluid drive seals are finished in our plant to an optical flatness of three light bands. Other components are engineered to comparable standards of precision.

In addition to shaft seals, HYDRON Bellows Assemblies are made to specification for direct or remote control of temperature and pressure. Write for details or forward sketches and specifications for recommendations . . . there's no obligation. CLIFFORD MANUFACTURING COMPANY, 566 E. First Street, Boston 27, Mass. Offices in Chicago, Detroit and Los Angeles. *First With the Facts on Hydraulically-Formed Bellows.*

CLIFFORD

HYDRAULICALLY-FORMED BELLOWS

ALL-ALUMINUM OIL COOLERS


Instrument Bellows
Aircraft Bellows Assembly
Steam Trap Bellows Assembly
Bellows Seal Assembly
All-Aluminum Cylindrical Oil Cooler
All-Aluminum Oval Oil Cooler

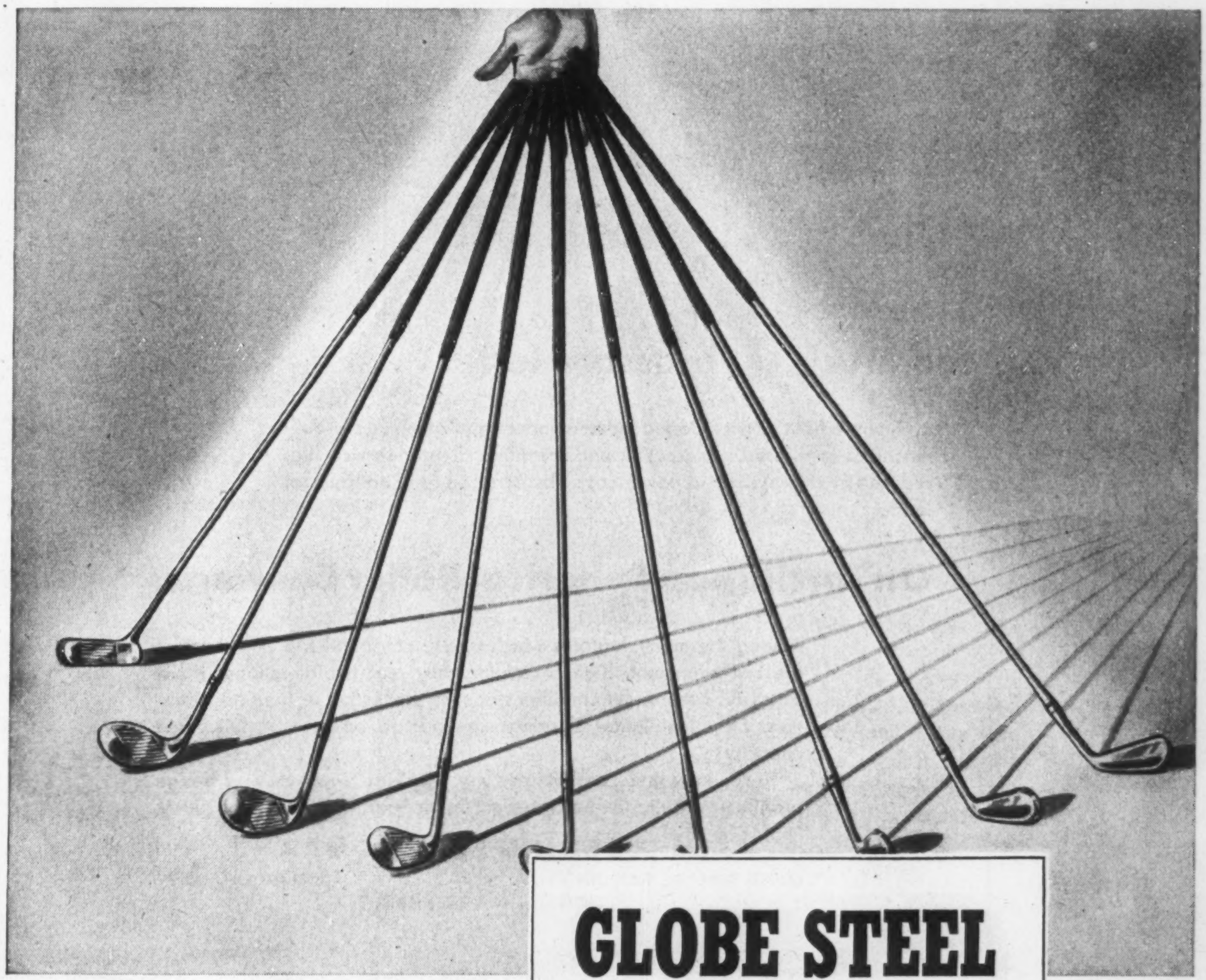
Matched for weight and matched for strength

Can you ever forget the fun of using your matched "clubs" for the first time; the thrill that comes each time you swing and feel and hear that solid click peculiar to a shot that's "in the groove". But don't overlook the fact that the shafts of matched clubs are steel tubes. For only with steel tubes can you get the uniformity in strength and weight—(plus economy of manufacture) that makes matched clubs possible.

Globe Steel Tubes Co. does not make matched golf clubs—our business is steel tubes in seamless carbon, alloy, stainless steels — high purity ingot iron tubing known as Globeiron — and welded stainless steel tubing called Gloweld. And in that business we exercise every precaution and care known to chemistry, physics and metallurgy to produce tubing "matched" in unvarying uniformity and quality. A fully equipped and staffed Globe laboratory helps to make that possible.

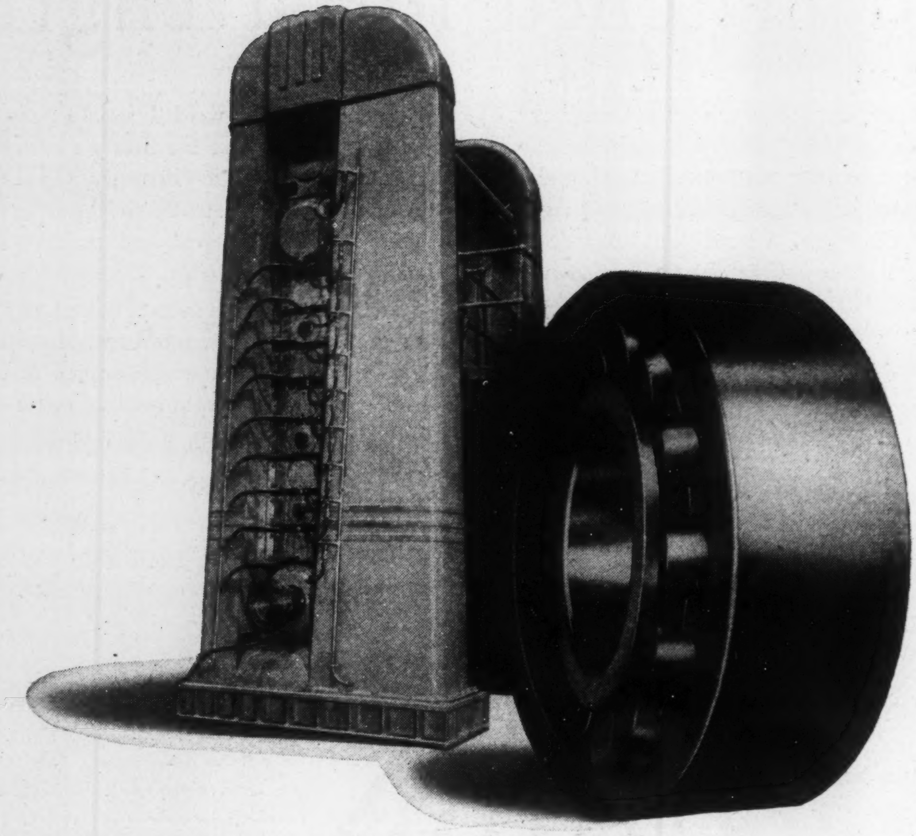
Your requirements in steel tubing may be just "staples" — or they may involve problems. In either case you can look to Globe as a dependable source of supply as well as a highly specialized organization eager to explore new fields in tubes and tubing applications.

Globe Steel Tubes Co. • Milwaukee 4, Wisconsin



Seamless Tubes—Carbon—Alloy—Stainless Steels—Welded Stainless Steel Tubing—Gloweld—High Purity Ingot Iron Seamless Tubes—Globeiron Mechanical Tubing—Pressure Tubing—Tubing for Corrosion and Heat Resisting Applications.

GLOBE STEEL
Tubes



You can stack up massive loads . . .

on intermediate rolls of paper supercalenders and other heavy-duty machines—and secure more efficient operation, longer service life, reduced maintenance and power costs—by carrying radial and thrust loads

On Torrington Spherical Roller Bearings.

Among the many features which assure consistent top performance are self-alignment, high radial capacity and two-directional thrust capacity. Even under conditions of shaft deflection or housing distortion, Spherical Roller Bearings continue to operate at full rated capacity.

To see how these advantages will "stack up" against your design problems, write today for Spherical Roller Bearing Bulletin No. 200-A.

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• NEEDLE • SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • BALL •

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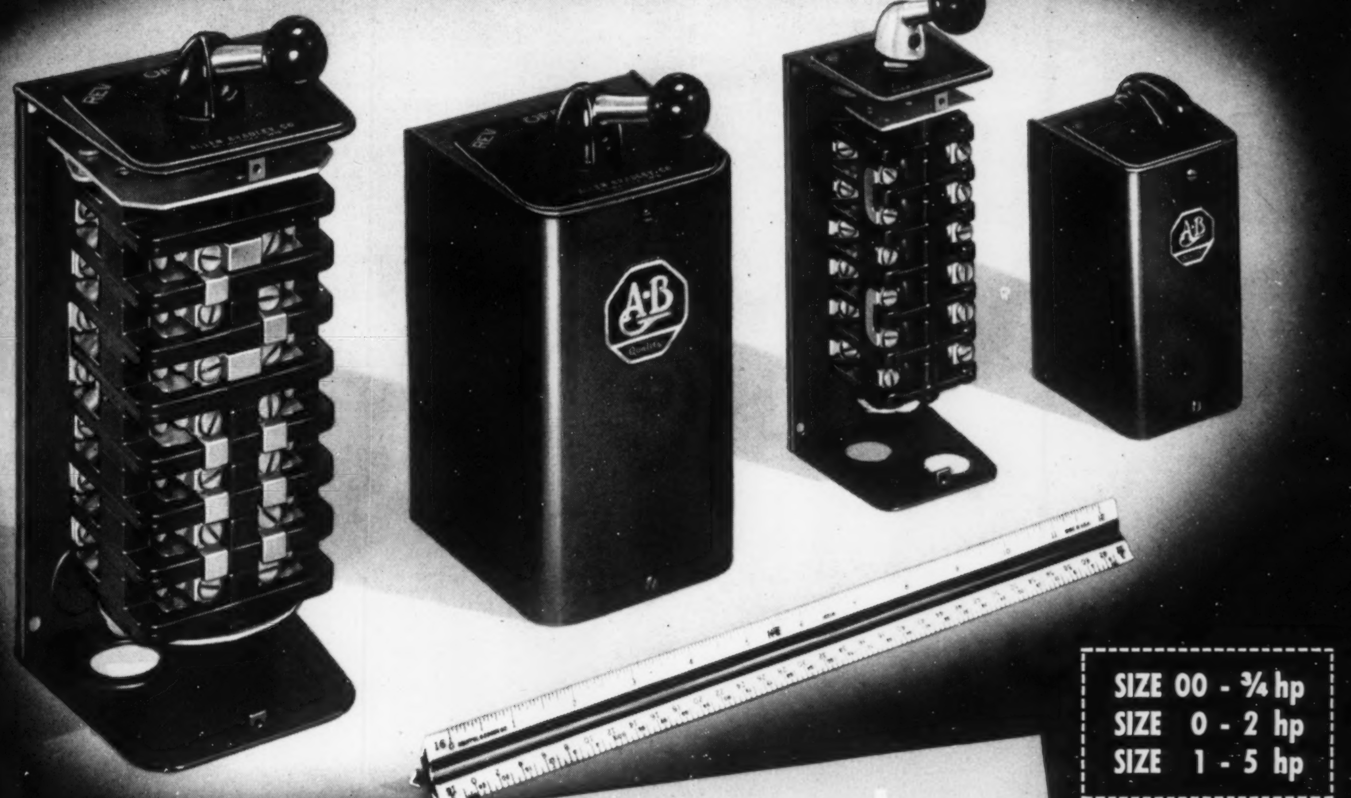
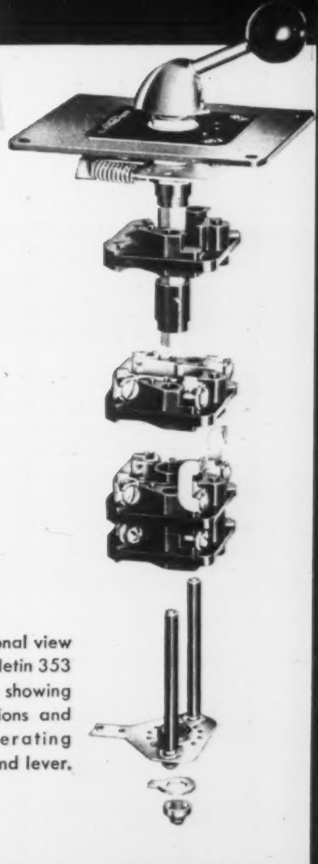
Small Cam-Operated DRUM SWITCHES



SIZE 00 - ¾ hp
SIZE 0 - 2 hp
SIZE 1 - 5 hp

for
Multi-Speed Motor Control
Reversing Service
Master or Transfer Switching

An 8-page bulletin is required to describe the great variety of applications and switching combinations of these handy Bulletin 353 cam-operated drum switches. They can be built up to 15 sections, with contacts opening or closing at any point of lever travel. Switching problems can be solved with surprising ease and simplicity. The silver alloy contacts require no cleaning or servicing, because any oxide which may form on the contacts is as good a conductor as the contact metal, itself. There are no sliding contacts . . . the beryllium copper fingers operate with a quick-closing and quick-opening action. Available in three sizes shown above.



Sectional view of Bulletin 353 Drum Switch showing contact sections and central operating shaft with hand lever.

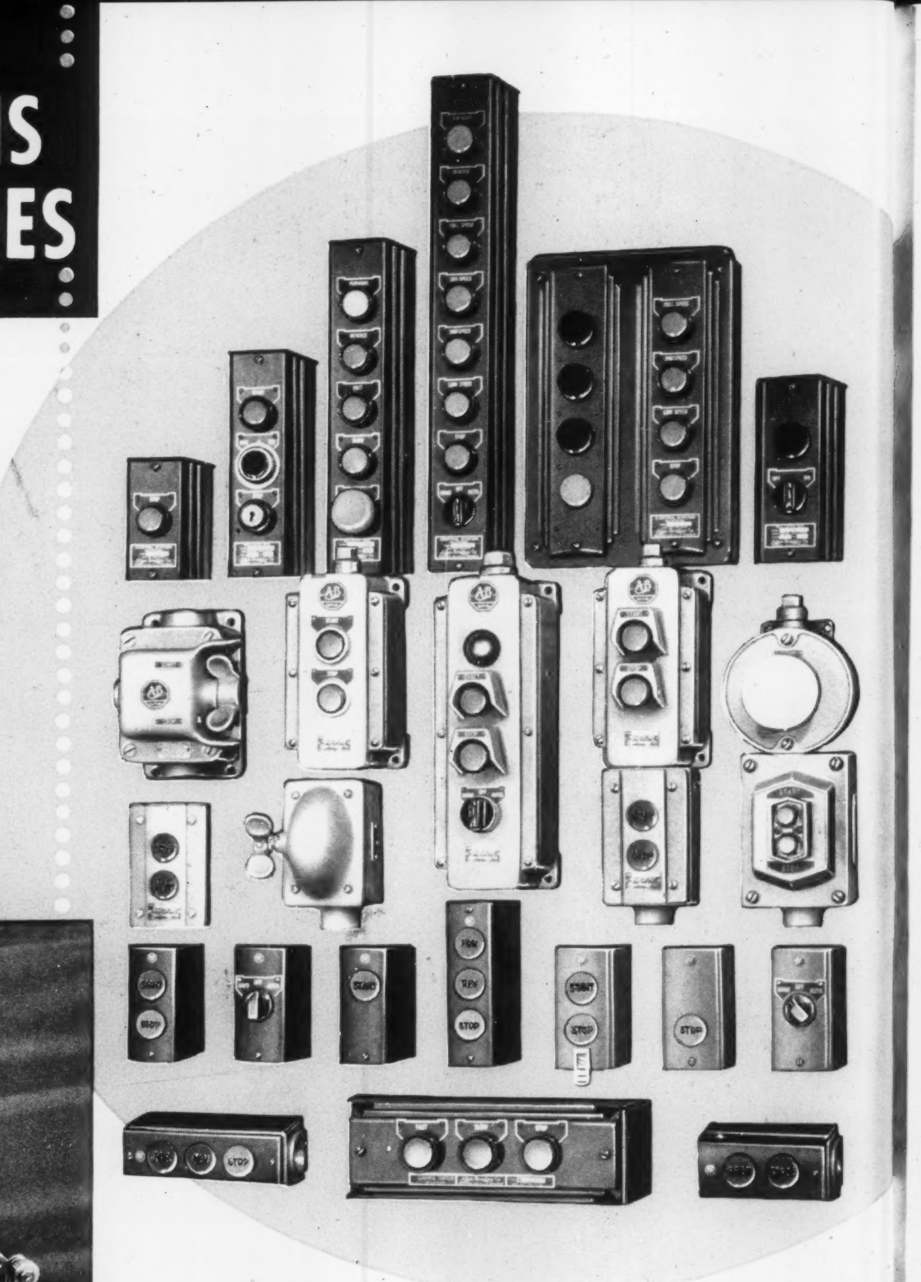
ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

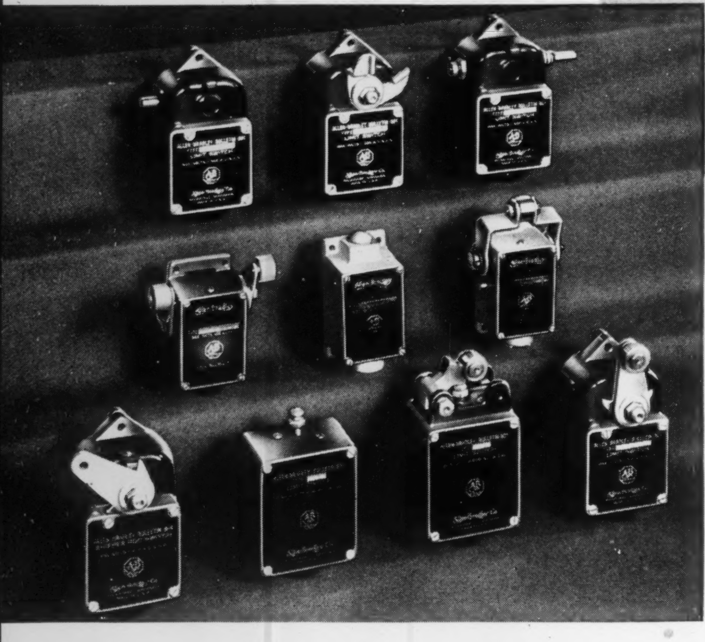
PUSH BUTTONS LIMIT SWITCHES

for

Manual and Automatic Control

If you are designing machines . . . or installing new machines . . . get the most out of them with push buttons or limit switches of the correct type. Added safety can be assured by using extra STOP buttons or perhaps a limit switch. Convenience, speed, and less spoilage are a few other advantages of adequate use of modern pilot control stations.





Limit switches are more than "stop-motion" units . . . they regulate machine speeds during bed travel or automatically put machines through a repeated sequence of operations. Send for Bulletin 801-802 on Allen-Bradley standard, heavy duty, and precision limit switches.

The above illustration shows 25 of the several hundred types of standard push button stations that are listed in Allen-Bradley Bulletin 800. But these few examples will serve to indicate the immense variety of enclosures, button labels, numbers of buttons, and also such auxiliary elements as pilot lights, selector switches, etc., which can be selected from the standard Allen-Bradley line to fit your needs. If you build or use motorized machines, by all means send for Bulletin 800, today.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

A-B
Quality

ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

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For unusual shapes and parts

... consider aluminum extrusions

From decorative trim to structural members Reynolds Aluminum extruded shapes offer outstanding advantages.

Strong aluminum alloys, less than half the weight of steel, give a highly favorable strength-weight factor for such applications as airplanes, windows, molding, and furniture.

Extruded in a single operation, "building up" is completely eliminated, cutting costly time and labor charges.

Reynolds Aluminum Extruded Shapes are rustproof . . . strong . . . light. Many stock dies are available. Costs for special dies are low. Consult Reynolds engineers on adapting Reynolds Aluminum Extruded Shapes to your needs. Write Reynolds Metals Co., 2521 So. 3rd St., Louisville 1, Ky.

Among the many current uses for Reynolds Aluminum Extruded Shapes are:

Windows	Busses
Irrigation Pipe	Garden Tools
Furniture	Store Fronts
Aircraft	Refrigeration
Textile Machinery	Railway Cars

Truck and Trailer Bodies

REYNOLDS METALS

REYNOLDS
THE GREAT NEW SOURCE OF **ALUMINUM**

2378

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EXTRA-UTILITY AT EVERY TURN WITH SCHATZ BALL BEARINGS

SCHATZ
"Commercial"
BALL BEARINGS

A lot of utility is packed into every Schatz "Commercial" ball bearing . . . the kind of rugged utility that stands up under the heavy loads of a coal conveyor or takes the steady punishment in a youngster's roller skates or bicycle.

High-grade, carburized, hardened and tempered, cold-rolled steel rings and through-hardened, precision chrome steel balls make the big difference in added load-bearing capacity, resiliency and over-all durability of "Commercial" ball bearings.

That's why these bearings keep "rolling along," delivering efficient anti-friction operation at every turn, whatever the service requirements.

Compare their on-the-job performance with other low-cost ball bearings. And consider, too, the plus value of Schatz engineering counsel while your application is in the design stage.

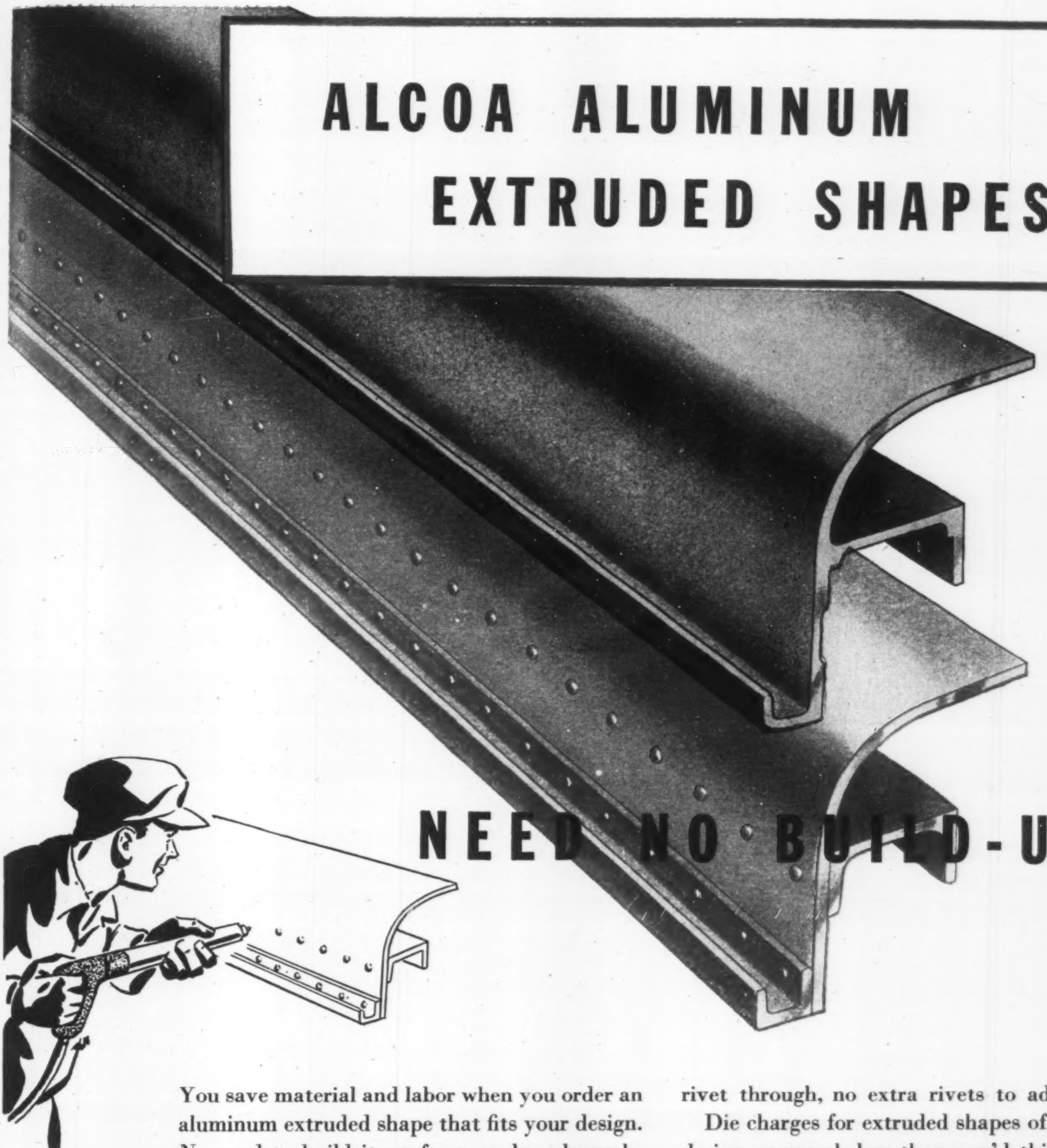
Schatz "Commercials" are manufactured in all standard types and sizes to cover the wide range of ball-bearing applications where moderate cost is a vital factor alongside of maximum efficiency. The answer to your anti-friction problem is among them.

Remember, Schatz makes only ball bearings, and "Commercials" are manufactured only by Schatz.

THE SCHATZ MANUFACTURING COMPANY
POUGHKEEPSIE, NEW YORK

REPRESENTATIVES LOCATED AT
Detroit: 2640 Book Tower—26 • Cleveland: 402 Swetland Building—15
Chicago: 8 S. Michigan Ave.—3 • Los Angeles: 5410 Wilshire Blvd.—36

THE LOW-COST, MULTI-PURPOSE BALL BEARING



ALCOA ALUMINUM
EXTRUDED SHAPES

NEED NO BUILD-UP

You save material and labor when you order an aluminum extruded shape that fits your design. No need to build it up from angles, channels, tees, and other conventional shapes.

The aluminum in an extruded shape is used at maximum efficiency . . . strength where strength is needed, economy of metal where loads are light. No lap joints and double thicknesses to rivet through, no extra rivets to add weight.

Die charges for extruded shapes of your own design are much less than you'd think.

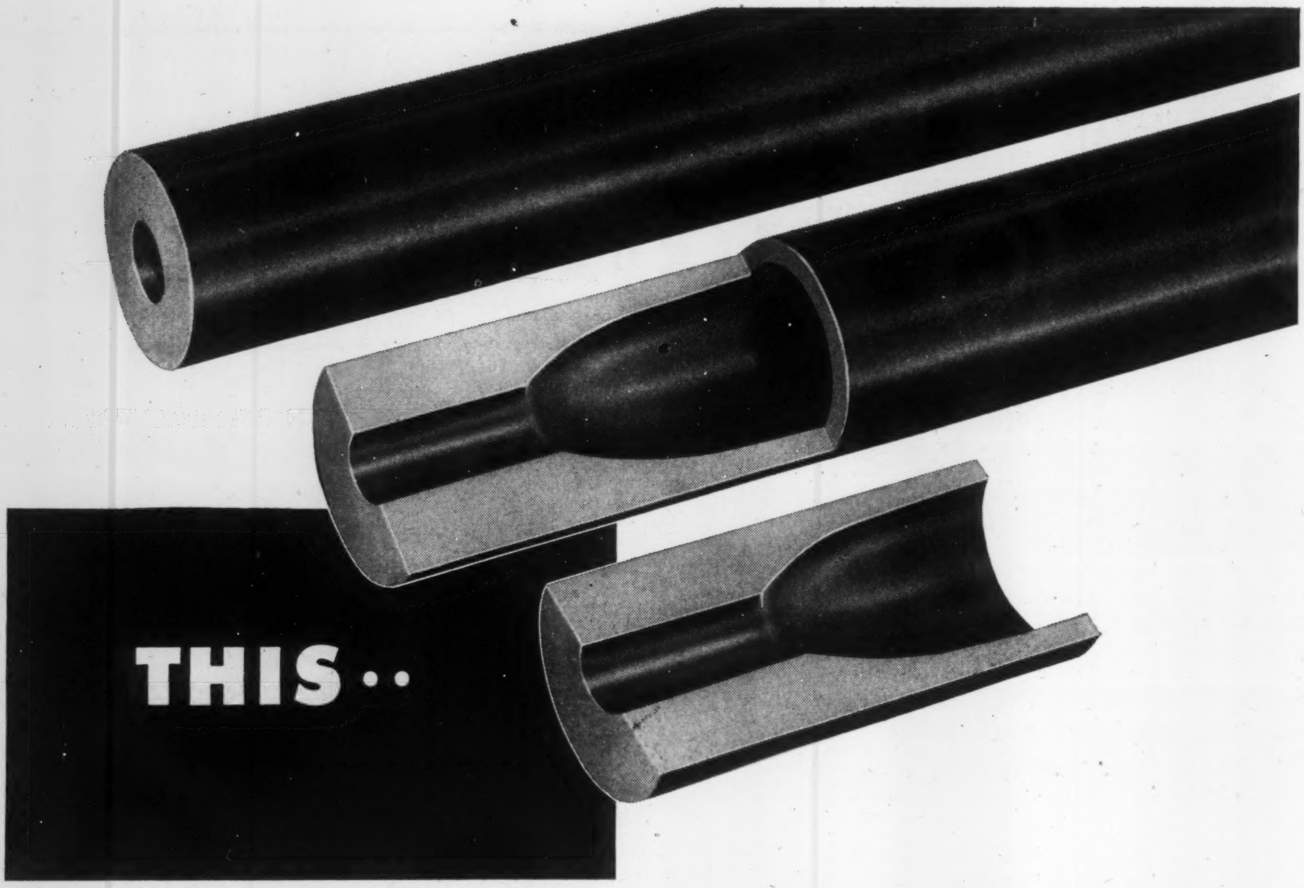
Our engineers will be glad to help you adapt Alcoa Aluminum Extruded Shapes to the things you make. ALUMINUM COMPANY OF AMERICA, 1940 Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in leading cities.

MORE people want MORE aluminum for MORE uses than ever

ALCOA FIRST IN ALUMINUM

ALCOA
ALCOA ALUMINUM

IN EVERY COMMERCIAL FORM



saves hours of machining time

The internal upset operation pictured here is typical of the many forming operations which The Ohio Seamless Tube Company is equipped to perform — operations that will help cut your production time and costs. On this particular application, the specifications called for tubing with heavy walls at one end only; the internal upset operation, performed on OSTUCO Seamless Steel Tubing by skilled craftsmen, completely eliminated the long, costly machining process formerly required.

●

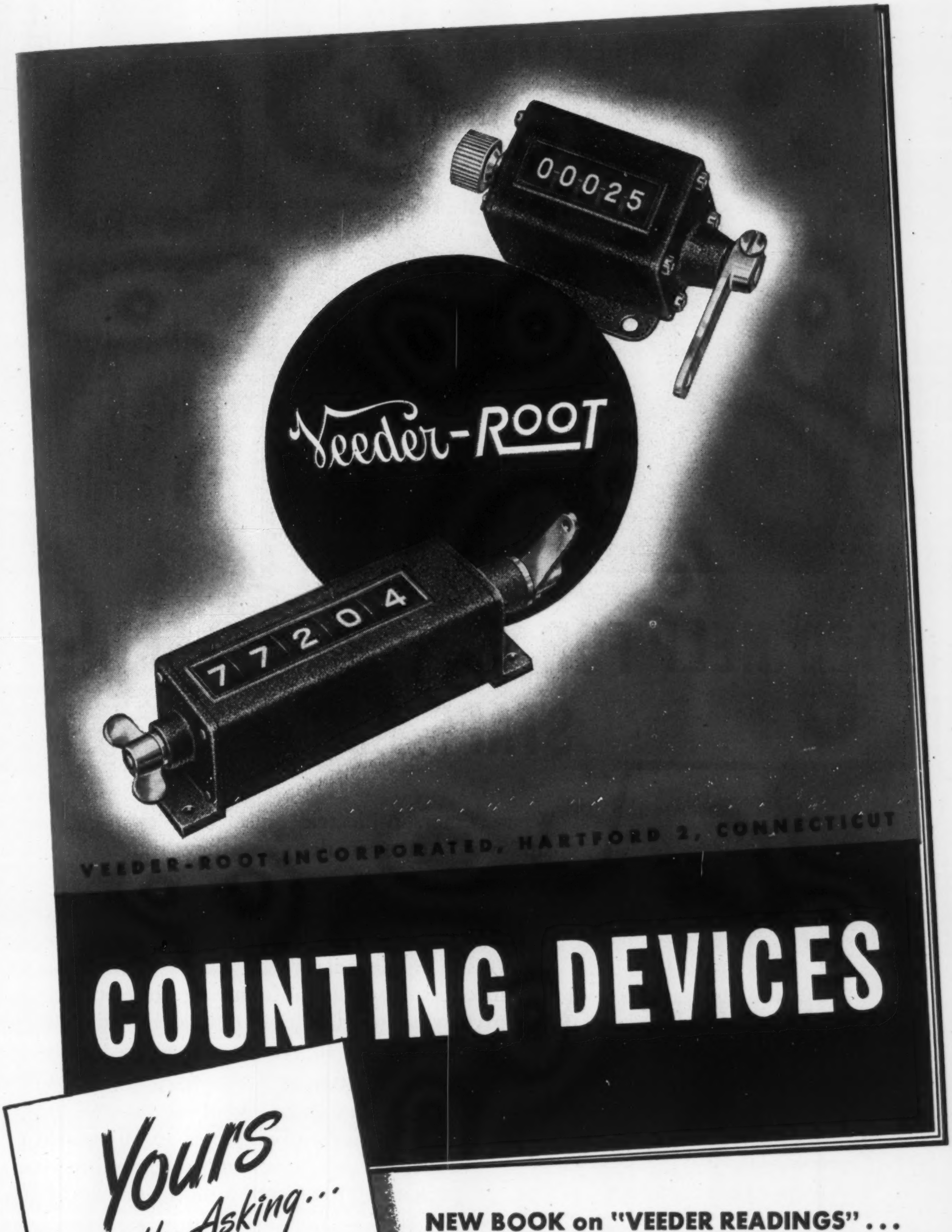
The manufacture of countless products in a wide variety of industries has been expedited through the use of OSTUCO Seamless Steel Tubing, formed to the most exacting specifications. Our sales engineers will gladly show you how OSTUCO can simplify your production problems, help cut production costs to a minimum and make yours a better product. Send us your specifications and blueprints.

OSTUCO

THE OHIO SEAMLESS TUBE COMPANY

***Plant and General Offices:* SHELBY, OHIO**

SALES OFFICES: CHICAGO, Civic Opera Bldg., 20 North Wacker Dr. CLEVELAND, 1328 Citizens Bldg. • DETROIT, 2857 E. Grand Blvd. HOUSTON, 927 A M & M Bldg. • LOS ANGELES, Suite 200-170 So. Beverly Drive, Beverly Hills • MOLINE, 309½—16th St. • NEW YORK, 70 East 45th St. • PHILADELPHIA, 123 S. Broad St. • ST. LOUIS, 1230 North Main St. • SEATTLE, 3205 Smith Tower • SYRACUSE, 501 Roberts Ave. • TULSA, Refinery Engr. & Equip. Co., 604 Ten E. 4th St. Bldg. • CANADIAN REPRESENTATIVE: Railway & Power Corp., Ltd., HAMILTON, MONTREAL, NORANDA, NORTH BAY, TORONTO, VANCOUVER and WINNIPEG.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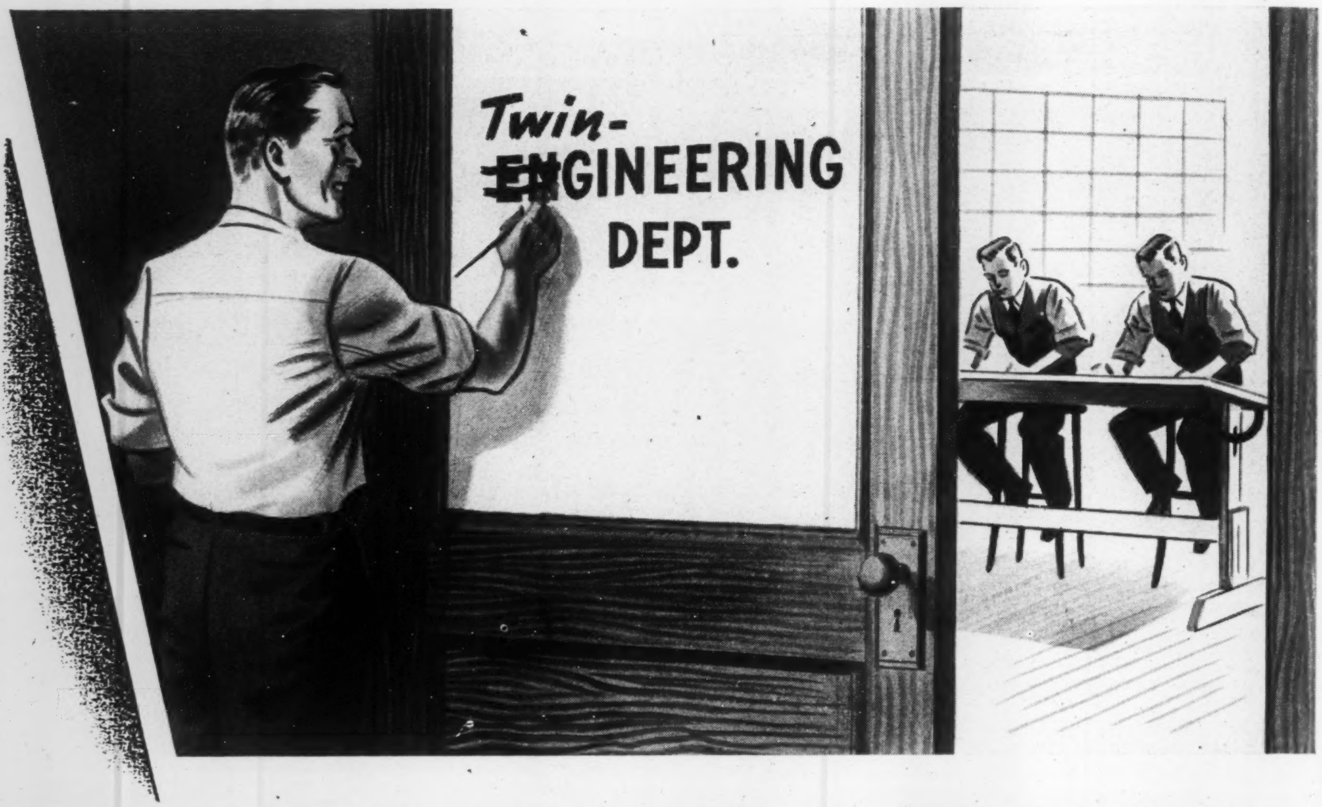
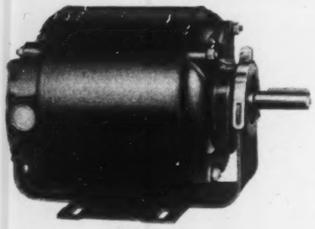
Veeder-Root
7 7 2 0 4
VEEDER-ROOT INCORPORATED, HARTFORD 2, CONNECTICUT
COUNTING DEVICES
Yours for the Asking...

NEW BOOK on "VEEDER READINGS" . . . just off the press! 12 pages of Quick Information on VEEDER-ROOT COUNTROL . . . and how and where to use it to top advantage. Write for your copy to: Dept. 687.

VEEDER-ROOT INC., HARTFORD 2, CONN.



ADDED HELP FOR YOUR ENGINEERING STAFF...*at no extra cost!*



1/20 to 5 Horsepower
Both AC and DC

For 56 years, Emerson-Electric has specialized in the application and manufacture of power motors, 5 H. P. and smaller.

THE EMERSON ELECTRIC MFG. CO., St. Louis 21, Mo.
Branches: New York • Chicago • Detroit • Los Angeles
Cincinnati • Davenport

When Emerson-Electric engineers "twin-up" with yours, in designing new motor-driven appliances, you enlarge your staff without adding to your payroll.

Such collaboration, or "Twin-gineering," helps you eliminate costly back-tracking, uncovers many manufacturing short cuts, gives your product the competitive advantages necessary to market success.

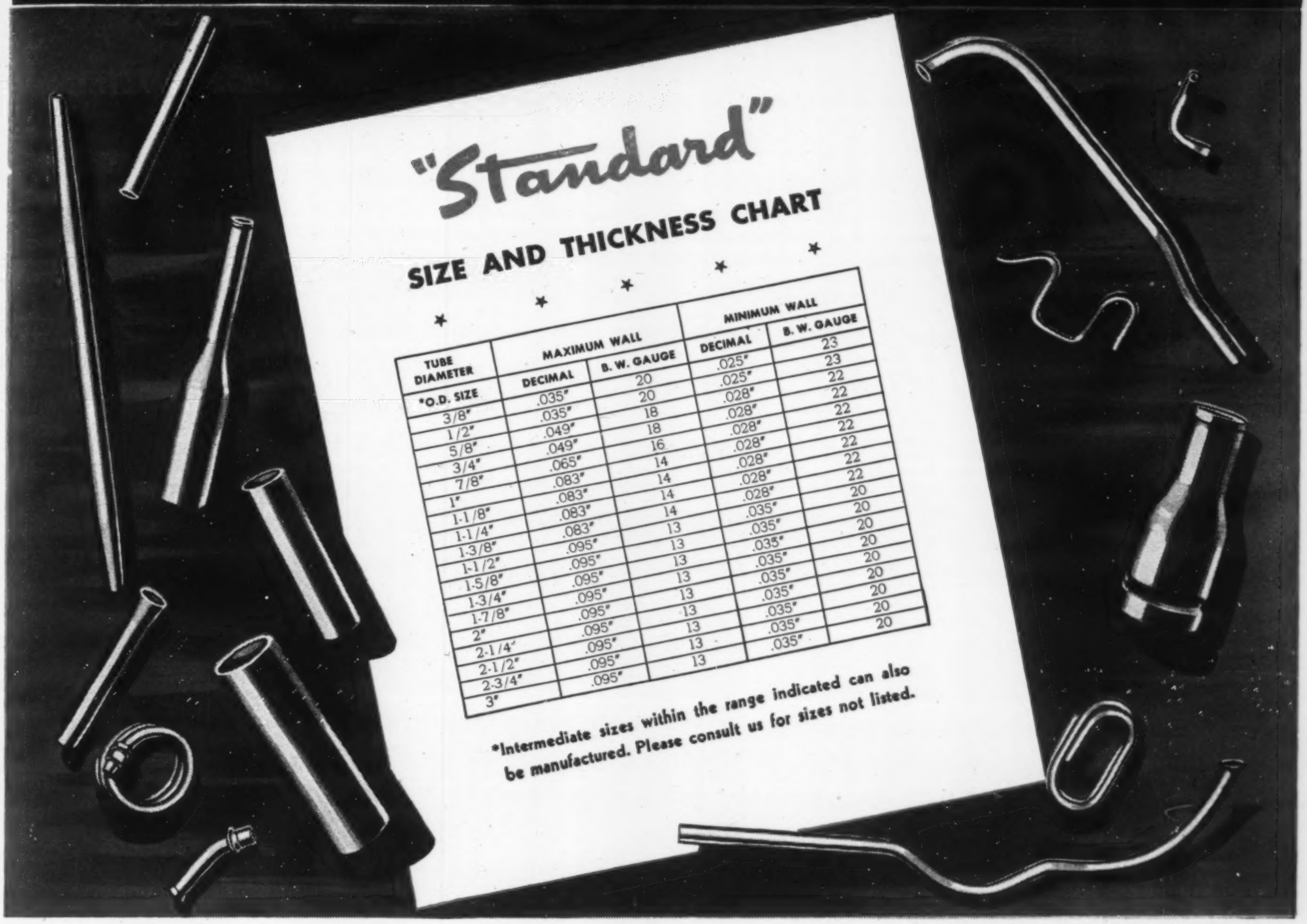
Our engineers have never been longer on ideas and experience, and never more willing to share these advantages in suggesting money-saving power applications for your present or prospective motor-driven appliances. Why not call us in?

36

EMERSON EMERSON ELECTRIC **ELECTRIC**

MOTORS · FANS APPLIANCES

NOW AVAILABLE
"Standard"
WELDED STAINLESS STEEL TUBING



"Standard"

SIZE AND THICKNESS CHART

TUBE DIAMETER	MAXIMUM WALL		MINIMUM WALL	
*O.D. SIZE	DECIMAL	B. W. GAUGE	DECIMAL	B. W. GAUGE
3/8"	.035"	20	.025"	23
1/2"	.035"	20	.025"	23
5/8"	.049"	18	.028"	22
3/4"	.049"	18	.028"	22
7/8"	.065"	16	.028"	22
1"	.083"	14	.028"	22
1-1/8"	.083"	14	.028"	22
1-1/4"	.083"	14	.028"	22
1-3/8"	.083"	14	.028"	22
1-1/2"	.095"	13	.035"	20
1-5/8"	.095"	13	.035"	20
1-3/4"	.095"	13	.035"	20
1-7/8"	.095"	13	.035"	20
2"	.095"	13	.035"	20
2-1/4"	.095"	13	.035"	20
2-1/2"	.095"	13	.035"	20
2-3/4"	.095"	13	.035"	20
3"				

*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.

Many Analyses for Numerous Applications

With more than a quarter of a century experience in the manufacture of Welded Carbon Steel Tubing, we have now added to our line, "Standard" Stainless Steel Tubing produced by the atomic Hydrogen Welded process.

"Standard" Stainless Steel Tubing can be furnished in the various analyses such as Type 302 - 304 - 316 - and 347.

"Standard" Stainless Steel Tubing is available for Mechanical, Pressure, Structural and Ornamental applications. Specify "Standard" and get the best.

STANDARDIZE WITH "STANDARD"—IT PAYS

THE STANDARD TUBE CO.

Detroit 3, Michigan

Welded Tubing *Fabricated Parts*

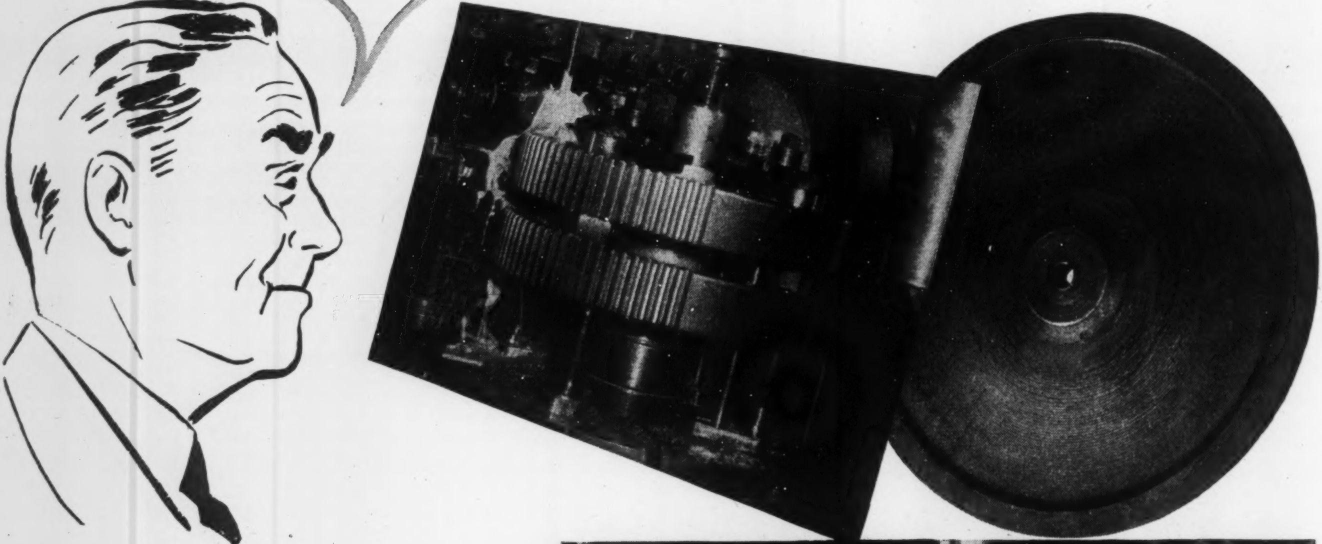
STANDARDIZE with "STANDARD" —It Pays

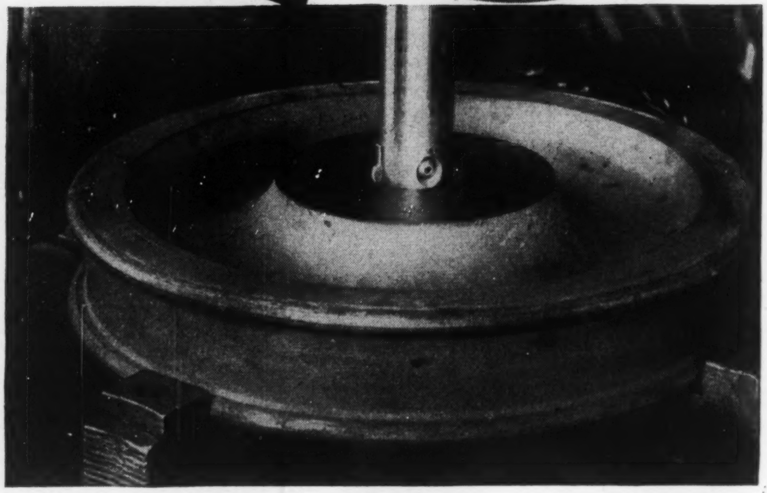
Also Producers of Electric Welded Tubing

★ *Complete Tube Stocks Maintained by* ★

STANDARD TUBE SALES CORP., 76-01 Woodhaven Blvd., Brooklyn 27, N. Y.
LAPHAM-HICKEY COMPANY, 3333 W. 47th Place, Chicago 32, Ill.
UNION HARDWARE & METAL CO., 411 E. First St., Los Angeles 54, Cal.
THE PACIFIC PIPE COMPANY, 160 Spear St., San Francisco 5, Cal.
METAL GOODS CORPORATION, 1300 Burlington, North Kansas City, Mo.

What's So Special About 'Em?





Plenty, sir!

Bethlehem circular products may look to you like any other kind. But the fact is, these circular steel blanks *are* different . . . and better in many ways.

They are made in a unique machine that combines the operations of upsetting, forging, and rolling—a process that gives the blanks homogeneity, excellent physical properties, and fine surface characteristics. Often the high quality of these products makes possible thinner sections; hence substantial savings in weight.

Another popular point with buyers is our rough-machining. This is not an "extra"; it is a standard service that goes with every order of Bethlehem circular forgings. See what we mean? Bethlehem rough-machines the job; *you* don't have to.

The blanks can be supplied in carbon or alloy steel, treated or untreated. Sizes from approximately 10 to 44 in. OD. Some of their many uses are shown in the list at the right.

Here are some of the things frequently made from Bethlehem circular forgings:

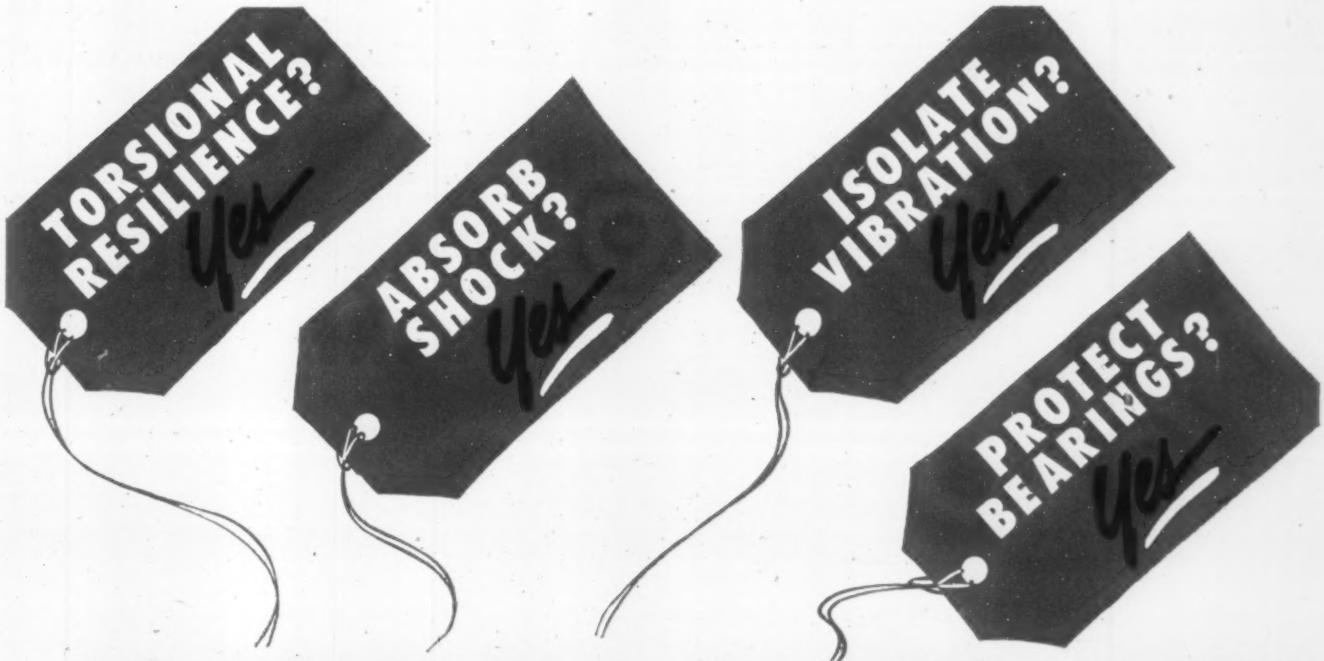
Gears (spur, bevel, miter) Crane Wheels
Flywheels Turbine Rotors Pistons
Sheaves Tire Molds Industrial Wheels
and many others

★ BETHLEHEM STEEL ★

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

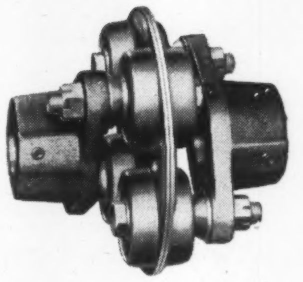
On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation

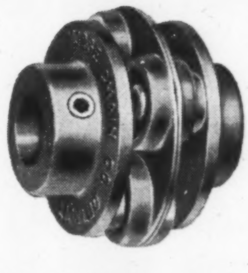
BETHLEHEM ROLLED · AND · FORGED CIRCULAR PRODUCTS

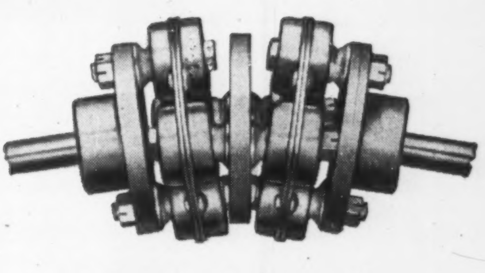

TORSIONAL RESILIENCE?
Yes
ABSORB SHOCK?
Yes
ISOLATE VIBRATION?
Yes
PROTECT BEARINGS?
Yes

MORFLEX COUPLINGS

have them ALL!







MORFLEX

The "floating center unit", composed of specially-designed, preloaded Neoprene biscuits, gives Morflex its flexibility. Morflex is available in nine sizes, from 20 to 725 lbs-ft of torque capacity.

MORFLEX JUNIOR

Same high-quality workmanship and precision engineering as its "bigger brother." Morflex Junior couplings are used in smaller power drives and accessories. Available in two sizes, 3 and 9 lbs-ft of torque capacity.

DOUBLE MORFLEX

Two Morflex center members joined to an adapter plate. Acting as a universal drive, it compensates for extreme angular or parallel misalignment of shafts. Double Morflex couplings available in 10 sizes, 13 to 725 lbs-ft of torque capacity.

CONSULT OUR ENGINEERS

MORSE CHAIN COMPANY • Detroit 8, Michigan • Ithaca, New York

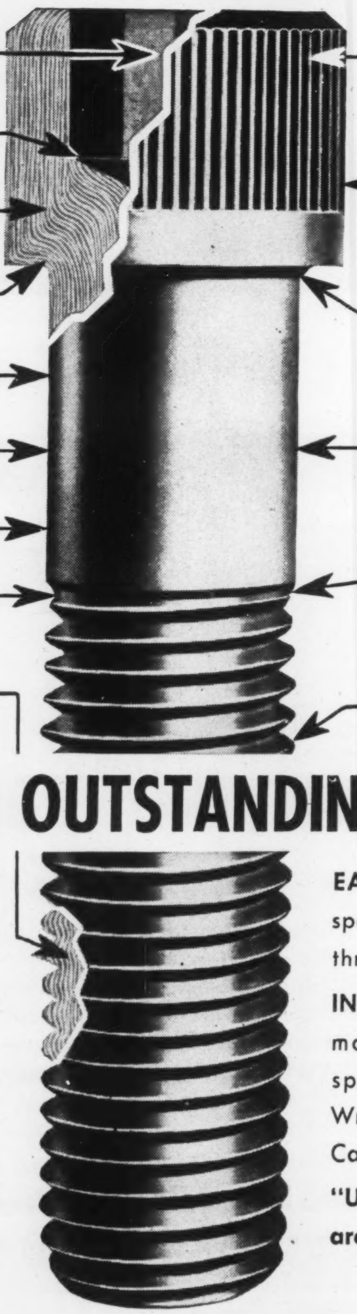
MORSE **MECHANICAL POWER TRANSMISSION PRODUCTS**

A PRODUCT OF B-W BORG-WARNER

These IMPORTANT FEATURES *of*

UNBRAKO KNURLED SOCKET HEAD CAP SCREWS

REG. U. S. PAT. OFF.



SPECIALLY MACHINED BROACH
UNIFORM SOCKET DEPTH
CONTINUOUS GRAIN FLOW
NATURAL FINISH NO MACHINING OR DISTURBANCE OF FIBERS
CONTROLLED HEAT TREATMENT
ALL STEEL MAGNETICALLY INSPECTED
ALLOY STEEL
CLOSE TOLERANCE ON DIAMETER
GRAIN FLOW ON ROLLED THREAD
KNURL CAN BE USED FOR LOCKING PURPOSE
KNURLED FOR FAST ASSEMBLY
CONTROLLED FILLET
SMOOTH BODY
CONTROLLED THREAD TERMINATION
PRECISION ROLLED THREAD CLASS 3 FIT

Give you these OUTSTANDING ADVANTAGES

STRENGTH, TOUGHNESS, RELIABILITY . . . the result of constant testing, inspection and quality control.

KNURLED HEAD FOR EASY ASSEMBLY . . . the knurled head provides a slip- and fumble-proof grip, even for the most oily fingers, therefore, the screw can be screwed-in faster and farther before it becomes necessary to use a wrench.

EASY START THREAD POINT . . . specially designed to assure fast, easy thread start.

INTERNAL WRENCHING . . . to promote Compact Designs which save space, material, weight and costs. Write for your copy of the "Unbrako" Catalog.

"Unbrako" and "Hallowell" Products are sold entirely through distributors.

We also make the famous "Unbrako" Socket Set Screw with the "Self-Locking" Knurled Cup Point, and the "Unbrako" Socket Set Screw with the "Self-Locking" Knurled Threads.

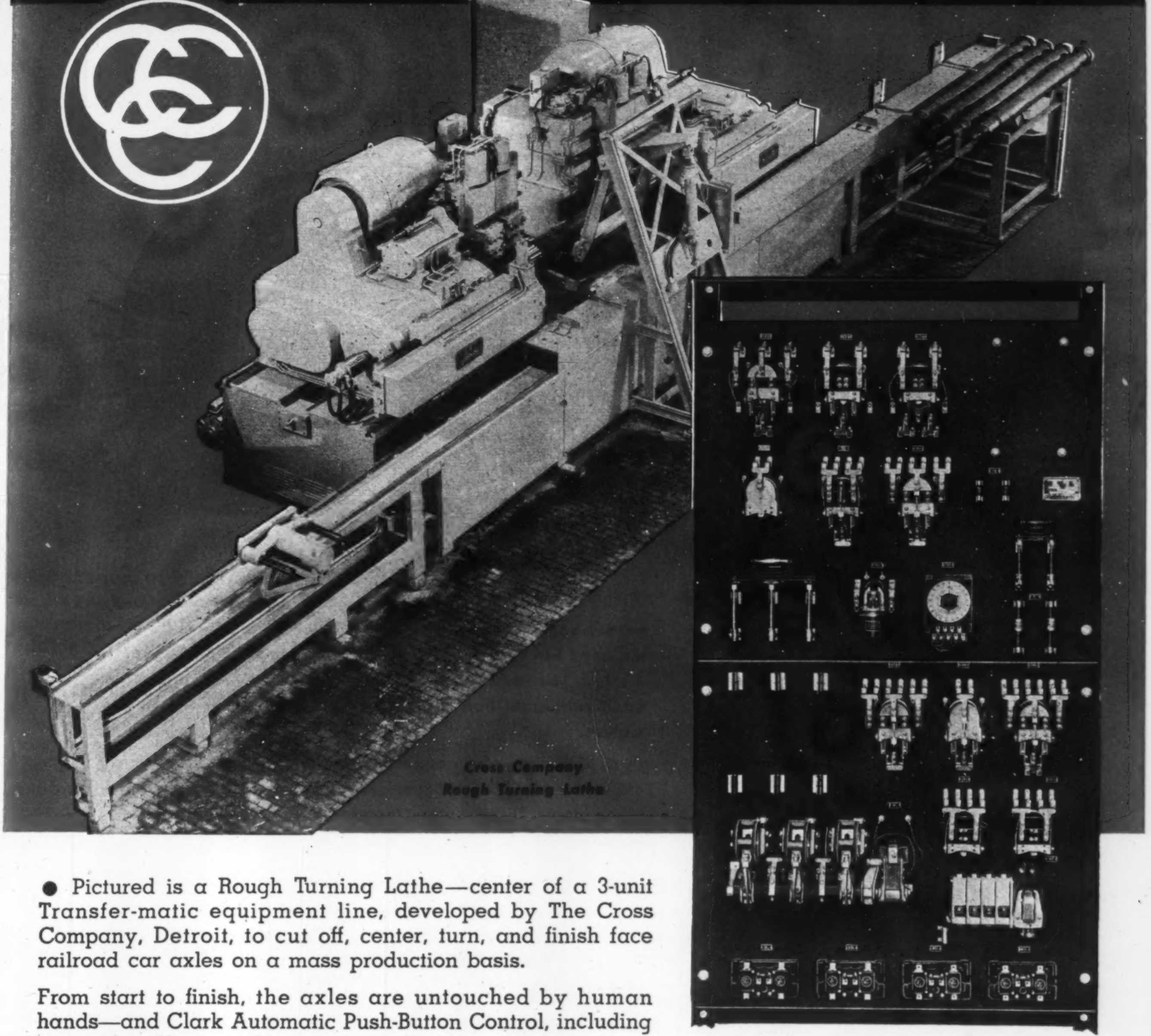
OVER 44 YEARS IN BUSINESS

Knurling of Socket Screws originated with "Unbrako" in 1934.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA., BOX 102 · BRANCHES: BOSTON · CHICAGO · DETROIT · INDIANAPOLIS · ST. LOUIS · SAN FRANCISCO

CLARK **HEAVY-DUTY** ELECTRICAL CONTROL *used in* MACHINE TOOL SERVICE



Cross Company
Rough Turning Lathe

Clark Control Panel for Rough Turning Lathe

- Pictured is a Rough Turning Lathe—center of a 3-unit Transfer-matic equipment line, developed by The Cross Company, Detroit, to cut off, center, turn, and finish face railroad car axles on a mass production basis.

From start to finish, the axles are untouched by human hands—and Clark Automatic Push-Button Control, including proper handling mechanism, served to cut costs.

The lathe has two 50 HP spindle motors, two 5 and one 1½ HP hydraulic pump motors, and 21 electrically operated solenoid valves.

Clark **HEAVY-DUTY** control, designed for **HEAVY-DUTY** service, performs effectively in this **HEAVY-DUTY** operation.

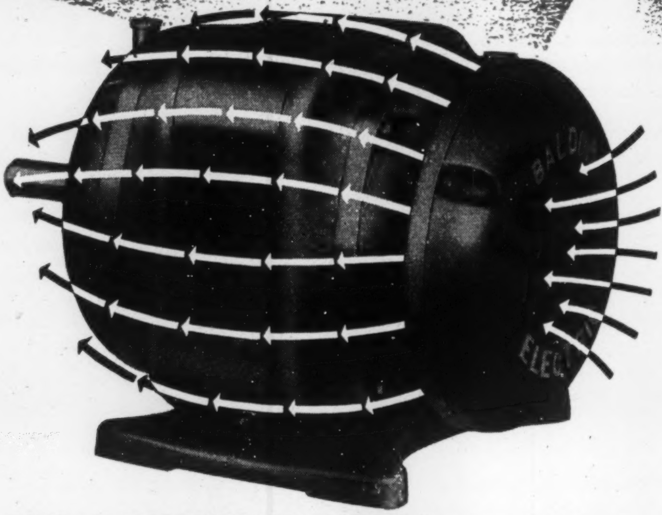
Clark engineers can solve your STANDARD or HEAVY-DUTY Machine Tool Electrical Control problems.

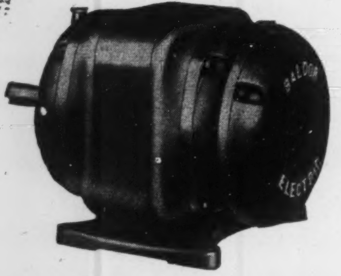
VISIT OUR BOOTH 14A
NATIONAL MACHINE TOOL SHOW
Chicago, September 17-26

THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO

These BALDOR Streamcooled Motors *can't inhale* Dust, Dirt or Lint



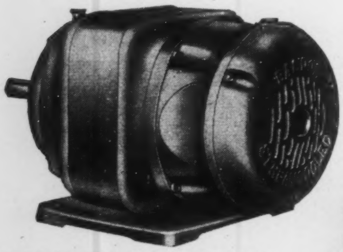


BALDOR STREAMCOOLED Polyphase Motor, 1 to 20 HP.

BALDOR STREAMCOOLED Direct Current Motor, 1 to 5 HP.

BALDOR STREAMCOOLED MOTORS ***are totally enclosed,*** **yet are constantly and efficiently cooled by a guarded outer-mounted fan forcing air over the entire exterior of the motor frame . . . as indicated by arrows in the above picture. This additional protection is an outstanding feature of all Baldor motors.**

Dust, dirt, lint, etc., cannot reach the inner mechanism of the motor to CLOG UP and reduce the operating efficiency of the motor. These motors, therefore, require LESS FREQUENT CLEANING . . . LESS SERVICING.



BALDOR STREAMCOOLED Single Phase Motor, ¾ to 7½ HP.

Baldor

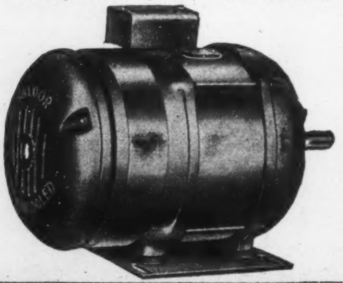
BETTER MOTORS

For More Than a Quarter of a Century

BALDOR STREAMCOOLED Face-mounted Vertical Motor, Single Phase, 3 Phase, and Direct Current.

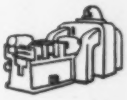
BALDOR STREAMCOOLED Face-mounted Motor, Single Phase, 3 Phase, and Direct Current.

BALDOR STREAMCOOLED Round Frame Motor, ⅓ to ¾ HP., Single Phase, 3 Phase, and Direct Current.



GENERAL OFFICES AND FACTORY, ST. LOUIS 10, MO.

to designers looking for:

a compact economical unit for positioning blades etc. . .	ROAD GRADERS, ETC.	
Variable speed, accurate fast control and consistently accurate duplication of movements . . .	PACKAGING MACHINERY, ETC.	
Fast, snappy action in moving heavy loads quickly and accurately to required heights . . .	MATERIALS HANDLING EQUIP., ETC.	
Effective speed and feed controls and consistently accurate clamping pressures.	MACHINE TOOLS, ETC.	

You'll find your needs in the proper combination of these SUNDSTRAND STANDARD HYDRAULIC ELEMENTS

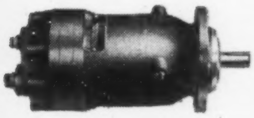
Yes, hydraulic circuits designed with the proper combination of these standard Sundstrand elements offers the best solution to your hydraulic equipment design problems. Proper combinations and circuit design are arrived at through design conferences between you and our hydraulic application engineers.

When designing new equipment or redesigning present models, call in a Sundstrand hydraulic application engineer. He will suggest the best combination of these hydraulic elements to meet your design requirements.

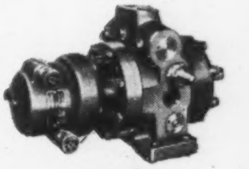
There is no obligation for this service.

FREE ADDITIONAL DATA is included in this set of bulletins. Write for your copies today. Ask for Bulletin M-20.

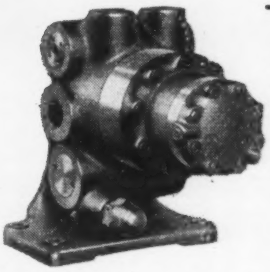
Hydraulic Equipment
SUNDSTRAND
OIL POWER
TRANSMISSION
SUNDSTRAND
OIL POWER
FLUID MOTORS



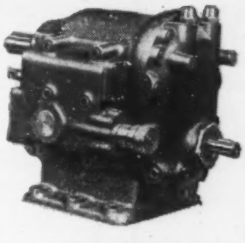
FLUID MOTORS



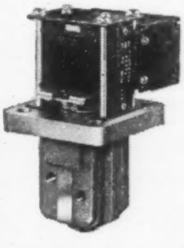
PUMPS



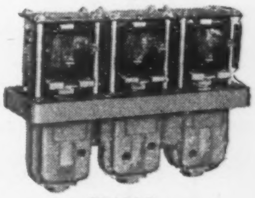
CLAMPING PUMPS



TRANSMISSIONS

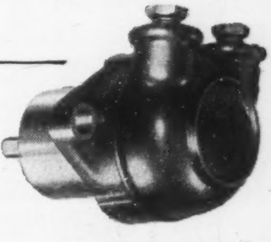


SINGLE SOLENOID VALVES



TRIPLE SOLENOID VALVES

FOUR-WAY VALVES



LUBRICATING PUMPS

SEE OUR EXHIBIT
at the Machine Tool Show, Dodge Plant, Chicago, September 17-26. Booth No. 21.

SUNDSTRAND MACHINE TOOL CO. ROCKFORD, ILLINOIS U.S.A.

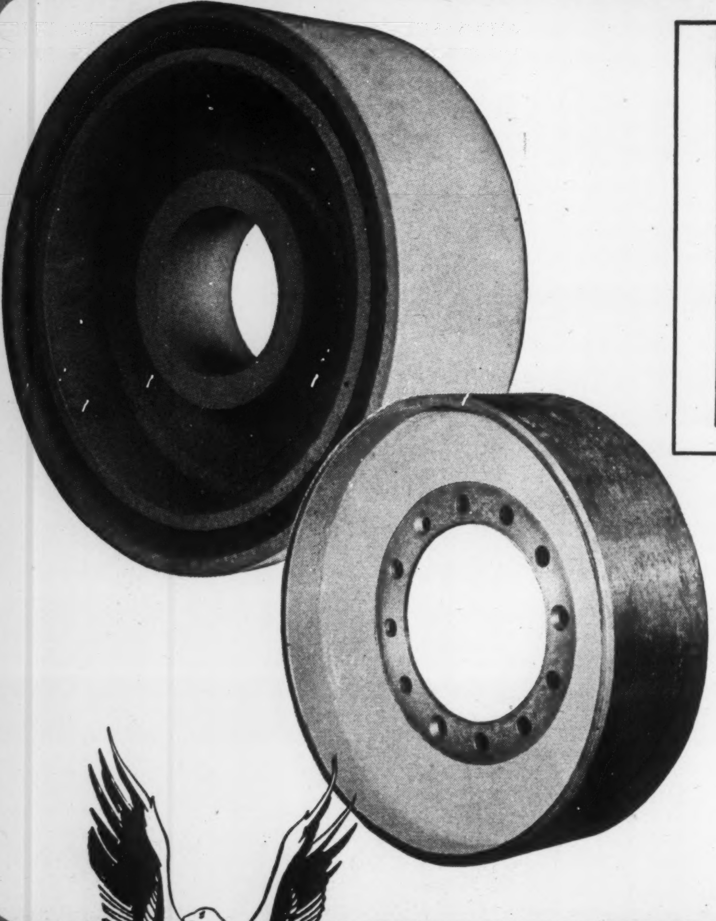
SUNDSTRAND PUMP DIVISION

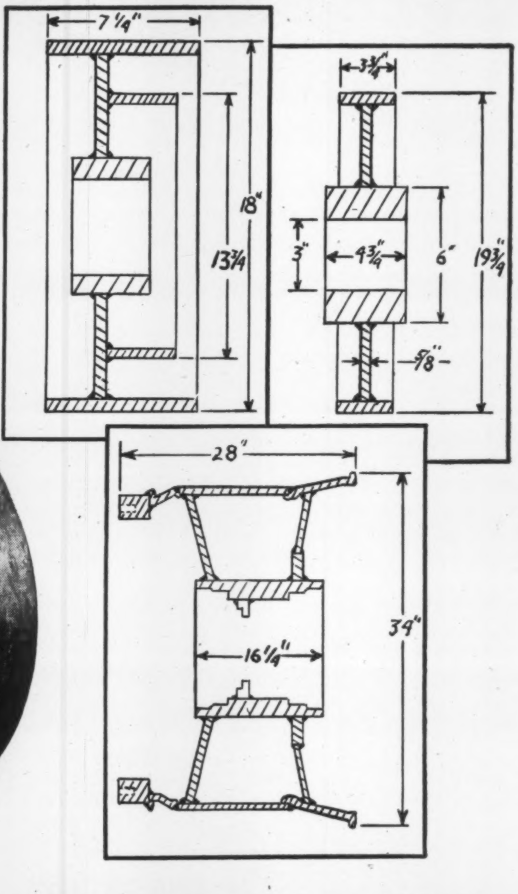
2559 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

WHEELS by AMERICAN WELDING

Very few products lend themselves more appropriately to the welding process than do industrial wheels. The fabrication by welding of industrial wheels makes it possible to design for specific loads at a minimum cost. Shown below are just a few of the many industrial wheels produced by us. Our engineers will gladly show you the advantages of welded wheel design. Write for our illustrated booklet.





THE AMERICAN WELDING AND MANUFACTURING COMPANY

3000 GRISWOLD ST. • WARREN, OHIO

* The first boat powered by steam, built by William Henry, and tested on the Conestoga River, near Lancaster, Pa., in 1763.

Management and work were needed to build the first steamboat*

Even the genius of William Henry — who helped emancipate man from the drudgery of hand labor — would have achieved nothing without sound management. Maker of the famous "Kentucky Rifle," Henry was also an able inventor of labor saving machines. In 1763, he built the world's first steamboat, that later inspired Robert Fulton. Henry combined management ability with imagination and energy to build a successful business. He typified the qualities that has made America productive.

Without able management to harness our inventive genius, and make it useful, our economy would still be back in the stage of primitive household industries. Sound management has transformed scarcity into abundance . . . has made possible a large population that enjoys the world's highest standard of living. How far we go from here may easily depend upon how well everyone appreciates the old fashioned virtues. Even able management can achieve little unless an honest day's work is given for a day's wages.

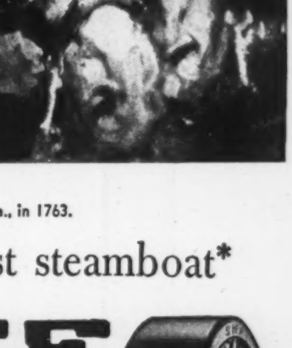
• • •

Steam transportation became modern and efficient only when friction in moving parts was conquered. In this development, SKF ball and roller bearings have played a major role. Made in many sizes and types, SKF bearings prove in steamships throughout the world that they are:

THE RIGHT BEARING FOR THE RIGHT PLACE

SKF

BALL AND ROLLER BEARINGS



7012-A

SKF INDUSTRIES, INC., PHILA., PA.

Let Trouble be our Introduction

THERE'S nothing like trouble to bring people together. That's how some of Revere's closest friends were gained—through a mutual struggle against difficulties, troubles such as occasionally beset any business.

Take the case of an important product, originally developed for war uses, now finding many applications in peacetime services. When manufacture began, rejections ran extremely high, over 40%, costs were skyrocketing, and badly-needed production was being lost. The maker asked if we would care to collaborate in solving the problem. Of course we would! After studying the subject in detail (and also under conditions of the greatest secrecy), we suggested a radical change in the properties of a non-ferrous metal used in the manufacture of the vital part with which so much trouble was being experienced. New processes of manufacture were developed, and in a short time test runs of the recommended material proved successful. Rejections of finished units dropped to less than 1%. Thus an expensive and vexing bottleneck was broken, and we gained a new customer and a firm friend.

This success story demonstrates that Revere has an open mind as well as an informed one, and is always ready to question the customary, find new answers to new problems, or to old ones, for that matter. If something is worrying you in your employment of non-ferrous metals, get in touch with Revere, not for ready-made answers, but for wholehearted cooperation, a joint search for better results. This help is given freely, without obligation, through the Revere Technical Advisory Service, which has at its command the knowledge and facilities of our laboratories, and the accumulated experience of the entire Revere organization.

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COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
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OXYGEN COUPLING

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Hardly a day passes that adaptations to new uses for Hansen couplings are not found—many being discovered right in the field.

The possibilities of Hansen Couplings are unlimited because of their simplified design, adaptability, and remarkable performance. They can be used anywhere, within their wide range of standard sizes, on anything that handles air, oil, grease, oxygen or acetylene—and will handle pressures from ounces to 10,000 pounds.

To connect a Hansen hose coupling, you merely push plug into socket—to disconnect, slide the sleeve back with your thumb. In both cases, flow is immediately and automatically turned on or off. No time wasted, no losses.

FOR
OXYGEN
ACETYLENE
AIR, GASOLINE
OIL, GREASE
STEAM

The adaptability of Hansen Couplings to so many different uses is the best possible evidence of their correct design. Our representatives will be glad to discuss with your engineers the possibilities and advantages of Hansen Couplings.

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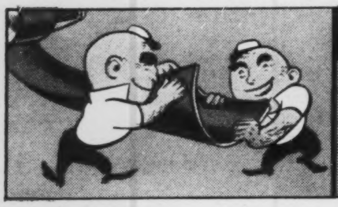
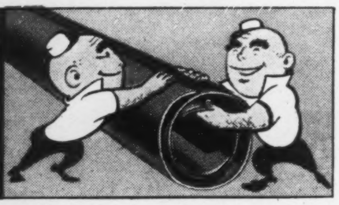
For men who leave nothing to chance

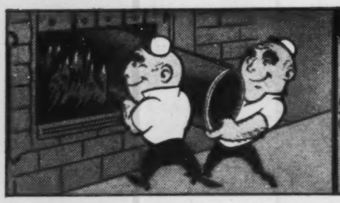
WHY BUNDYWELD IS BETTER TUBING



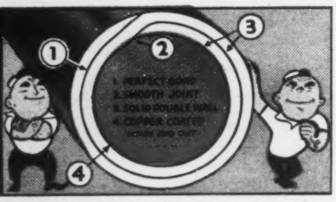
1 Bundyweld Steel Tubing is made by a process entirely different from that used in making other tubing. A single strip of copper-coated S.A.E. 1010 steel is continuously rolled twice laterally . . .



2 . . . into tubular form. Walls of uniform thickness and concentricity are assured by the use of close tolerance cold rolled strip. This double rolled strip passes through a furnace where the . . .



3 . . . copper coating fuses and alloys with the double steel walls. After brazing and cooling, it becomes a solid double wall steel tube, copper brazed throughout 360° of wall contact . . .



4 . . . copper coated inside and out, free from scale, closely held to dimensions. Hard or annealed in standard sizes up to ⅝" O.D. Special sizes cold drawn. Also in Monel and nickel.

Tubing buyers who leave nothing to chance—even men as cautious as the gremlins above in holding up their pants—are welcome people at Bundy.

The reason for this is plain.

Bundyweld* Tubing is made to meet requirements in trucks and automobiles, modern freezing units, gas ranges, Diesel engines and other products where tubing is used. Even the most careful buyer can rely on Bundyweld for dependable performance.

Here are some of the more important advantages made possible through the patented Bundyweld process:

- **solid, double wall**
- **great resistance to vibration fatigue**
- **strength combined with ductility**
- **uniform tolerances**
- **ease of fabrication**
- **high bursting strength for pressure applications**
- **low cost**

Chances are, we can help you on your tubing problems. Write today. *Bundy Tubing Company, Detroit 14, Michigan.*

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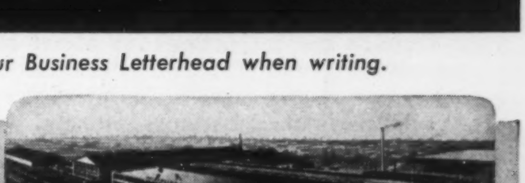

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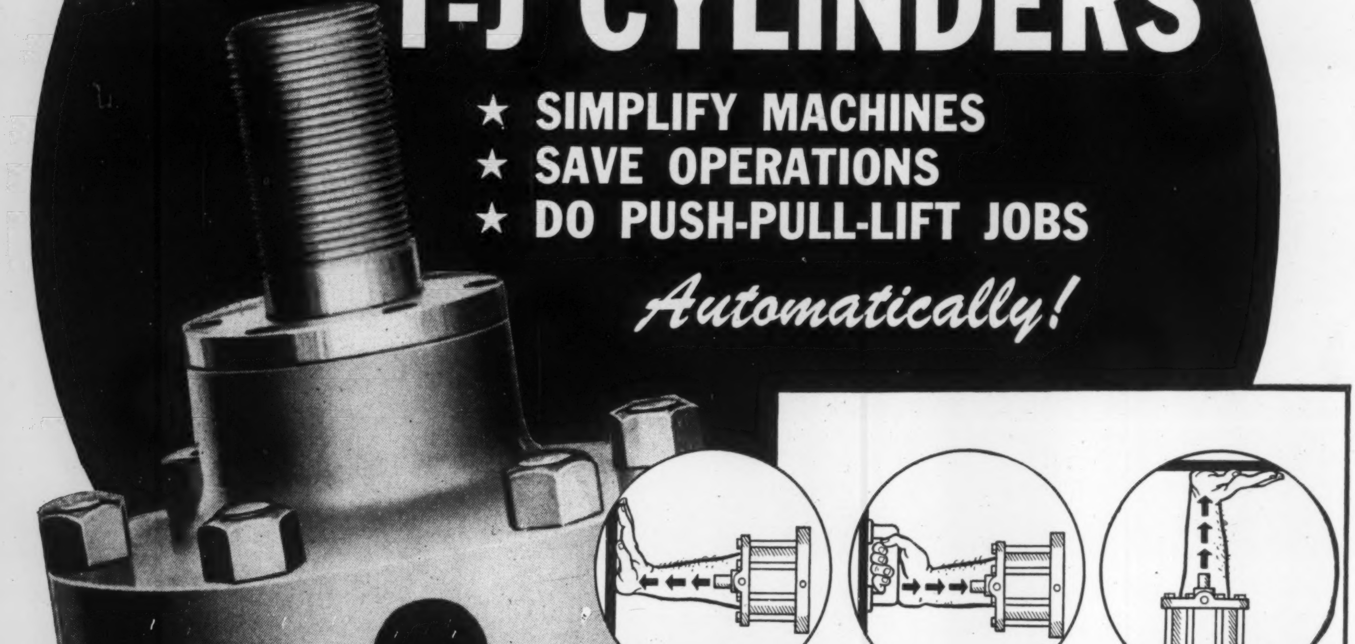

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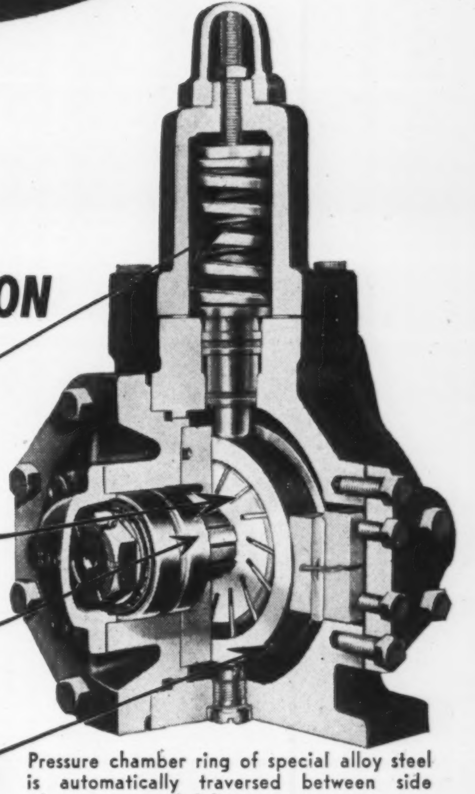

1 Spring governor provides automatic volume control, supplying only the needed flow of oil at a pre-determined pressure.

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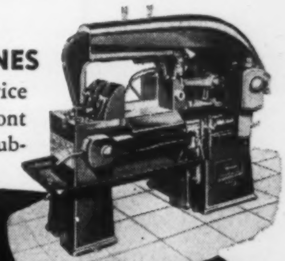

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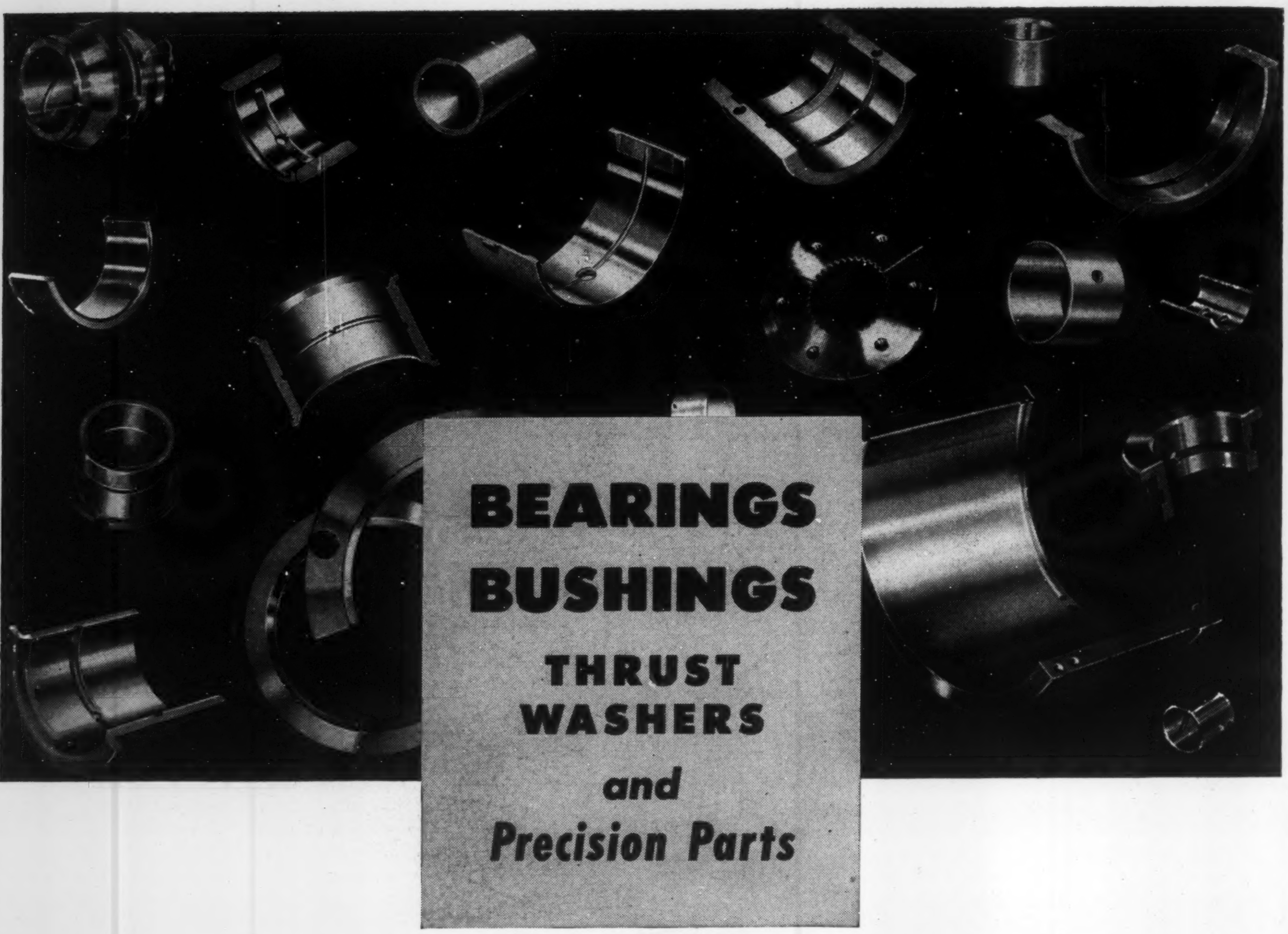

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How Many Bearings in Your Plant?

Trabon Lubrication Systems can Save You $5 to $8 per bearing per year!

LUKE THE LUBRICATOR

IT'S a matter of simple arithmetic. Each bearing requires at least one minute per day of your lubricating man's time. At prevailing wage rates you are paying at least 1.7¢ per day for once-a-day lubrication of each bearing. Multiplied by 300 working days a year *each bearing is costing you $5.10 per year in man-hours alone!*

Trabon Centralized Lubricating Systems will put this money back in your pocket. Hundreds of bearings can be lubricated in a few moments' time, positively, accurately. And there are other savings, too. Trabon Systems eliminate "down-time" for lubrication. Machinery is lubricated while it is in operation. Bearing repair bills are slashed. Breakdowns and expensive lost production time are eliminated. Lubricant is used more efficiently. *These savings add up to anywhere from $8 to $10 per bearing per year on the average machine.*

Take an ordinary press with 20 lubricating points. In a year's time—at $8 per bearing—you save at least $160. *At that rate your Trabon System will completely pay for itself in considerably less than two years!*

Trabon Systems are in daily use on blast furnaces, cranes, conveyors, coal crushers, canning and bottling machinery, machine tools, mills, and mill tables, manipulating and handling equipment, ore bridges and unloaders, presses and forging equipment, rubber mills and mixers—in fact anywhere that bearings require systematic lubrication. Let Trabon's generation of experience in industrial lubrication help solve your lubricating problems. Use the attached business reply card for more information on Trabon Positive Centralized Lubricating Systems.

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2. **Eliminate Lost Production from Bearing Breakdowns**
3. **Reduce Lubricating Man-Hours**
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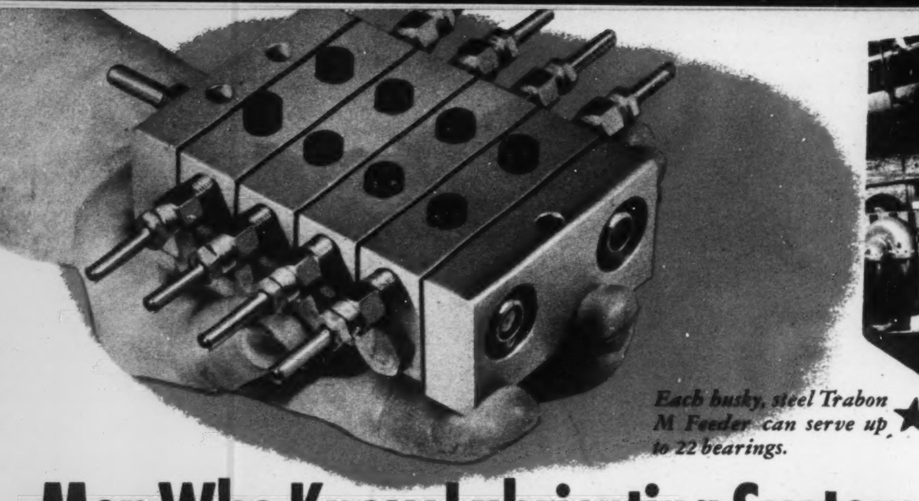

Each busky, steel Trabon M Feeder can serve up to 22 bearings. ★

Men Who Know Lubricating Systems

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Check these Operating Features and you'll realize why plant engineers and master mechanics prefer Trabon

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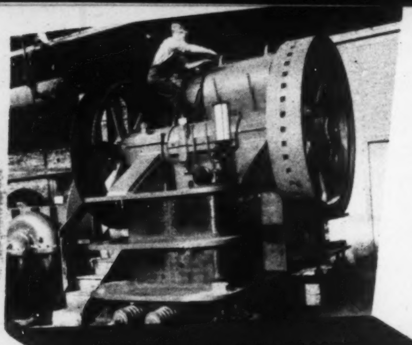
2. **Progressive Operation**—Feeder sections operate progressively, one after the other. Each piston discharges its full measured amount of lubricant before the main hydraulic flow from the pump can reach and operate the next piston. *This makes it impossible to skip or under-lubricate a bearing.*
3. **Only One Indicator to Watch**—The single indicator at the pump tells the whole story, giving positive proof when *every* bearing has received its full measured amount.
4. **Rugged, Steel, Sealed Feeders**—vibration-proof, heavy steel feeders are completely sealed and have no exposed moving parts. The sealed Trabon System can be buried underneath dirt, grime, coal dust or even concealed inside the machinery. For the single indicator at the pump tells the story!
5. **Wide Range of Discharges**—Trabon Feeders can provide extreme variations in lubricant discharges. A complete line of manual and automatic pumps meets the needs of lubricating systems of all sizes and types.

Let Trabon's Generation of Experience Help Solve Your Lubricating Problems



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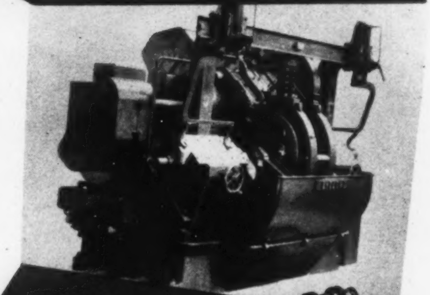

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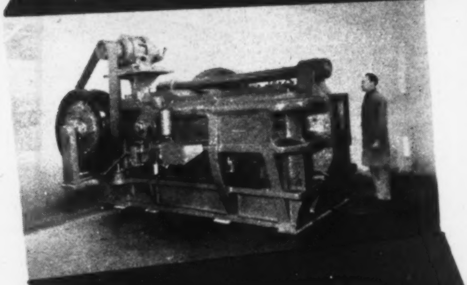

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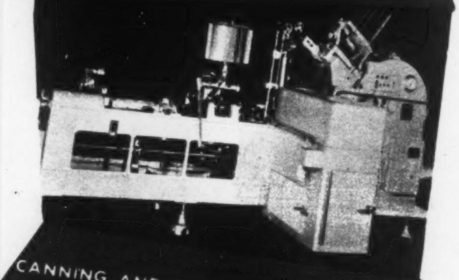

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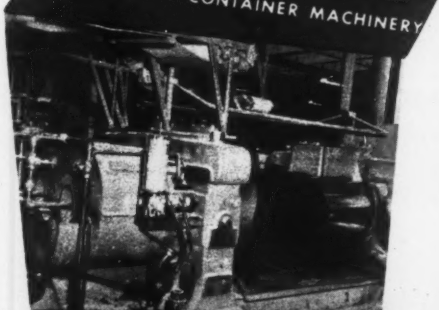

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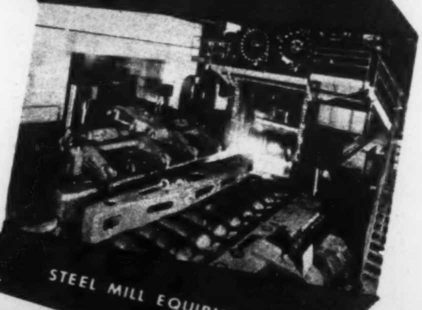

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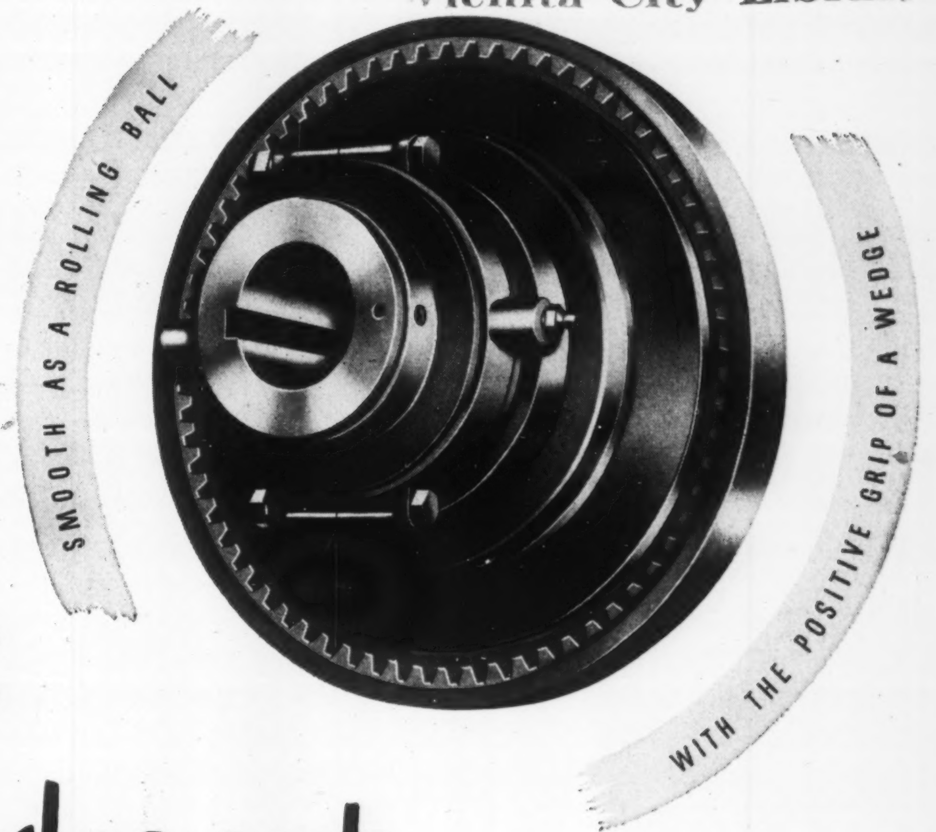

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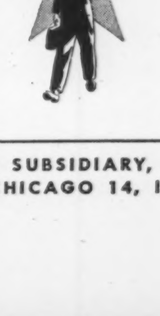

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Another ARI Project for Industry

As the uses of aluminum castings grow in importance to industry, so grows the need for up-to-date knowledge about aluminum alloys.

Aluminum Research Institute has brought together, in one compact volume, comprehensive data on the more commonly used aluminum casting alloys. The information derives from a major research program conducted for ARI by one of America's leading technical schools.

This new book—*"A Manual of Aluminum Casting Alloys"*—contains sections on the general metallurgy of aluminum alloys, properties of specific sand and permanent mold casting alloys, foundry practice, and heat treatment.

For your copy, write on your company letterhead to Aluminum Research Institute.

General Smelting Company
Philadelphia 34, Pennsylvania

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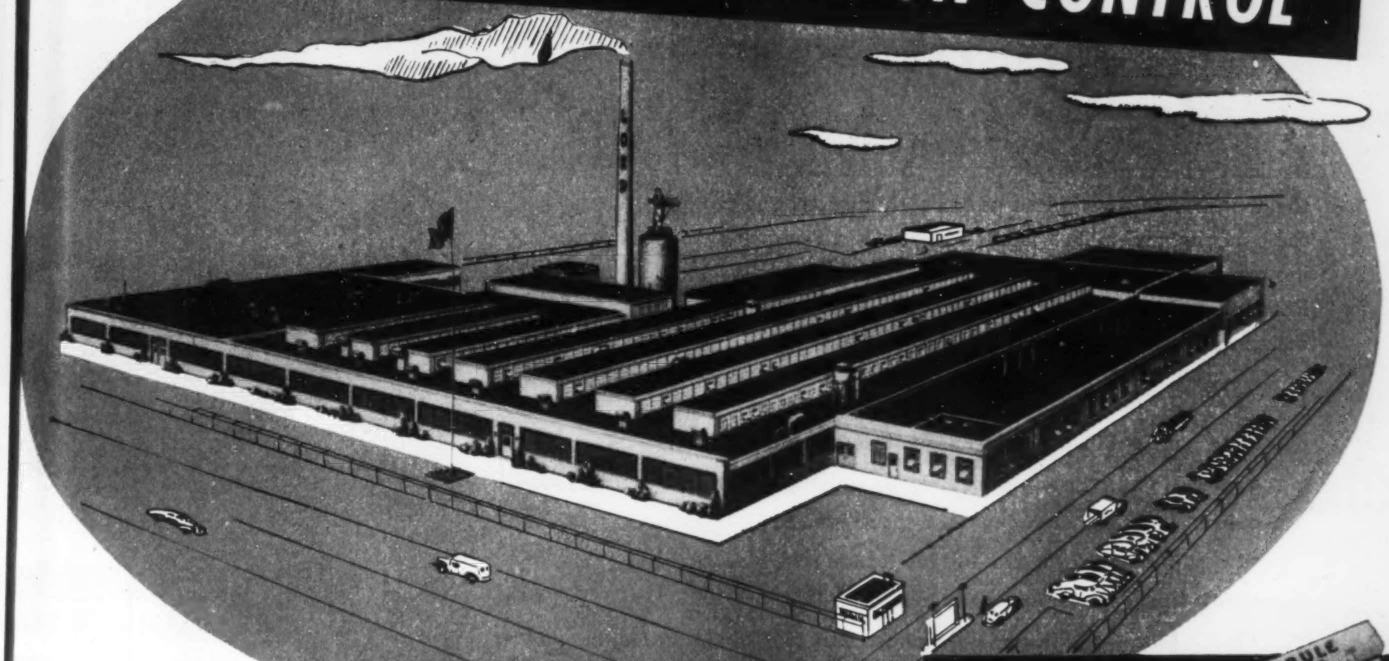
FOR VIBRATION CONTROL



VIBRULE
LORD

USE LORD ENGINEERING SERVICE TO SOLVE YOUR PROBLEMS IN ELIMINATING COSTLY VIBRATION AND NOISE

Do you plan to make more, sell more, and profit more . . . in the face of the strongest competitive market ever known? First—better take another look at your product. Does it have *minus* sales appeal caused by destructive, costly, nerve wracking vibration and noise?

Vibration can be eliminated and the solution is simple and free . . . add LORD to your engineering staff. Use Lord's specialized know-how in Vibration Control—without obligation. Send us your problem . . . trained Lord engineers plus the finest of research facilities plus long, practical experience are at your disposal.

If you intend to design the kind of smooth, quiet product that outsells competition, then here's a valuable, helpful service worth investigating. Write or phone us today.

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SEND FOR YOUR LORD VIBRULE . . . . ANOTHER LORD SERVICE IN VIBRATION CONTROL

- Use the Lord Vibrule to solve difficult vibration problems . . . measures vibration quickly, easily.
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Please send me without cost LORD VIBRULE . . . . ☐

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Scoop it . . . swing it . . . dump it—faster, easier

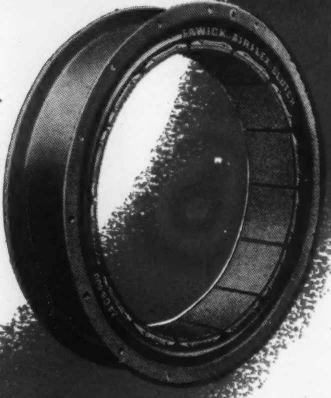
WITH FAWICKS

Fawick Clutches have amply proved themselves under the toughest field service conditions throughout the earth-moving and mining industries. That's why leading manufacturers now build Fawicks into their draglines, shovels, loaders, ditchers, rollers and other materials handling equipment.

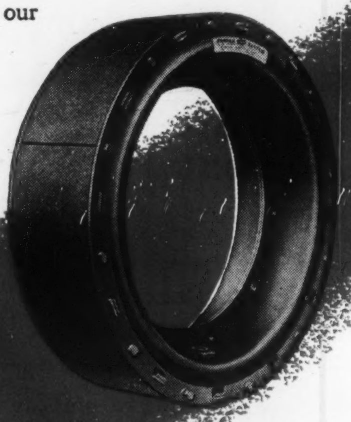
Users profit by these unique, moneysaving advantages:

- **Torque controlled, shocks absorbed by a cushion of air.**
- **No strain on any part of machine in quick starts and stops under load.**
- **No arms, levers or springs to wear or break.**
- **No adjustments to make—no lubrication required.**
- **Maintenance costs unusually low.**
- **Entire machine protected against needless loss of productive time.**

If clutch down time is costing you money, let our Engineering Department give you our recommendations.

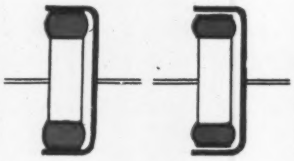


TYPE CB—The Fawick Type CB Airflex Clutch transmits power through friction shoes carried on the inner surface of the rubber-and-cord tube . . application or release of air pressure provides immediate, positive clutch action . . rubber and air cushion protects entire machine against shock and vibration, compensates for operating wear of friction blocks.



TYPE E—The Fawick Type E Clutch transmits torque from the friction shoes through cross-member torque bars . . . extra thick friction blocks protect rubber tube against destructive heat.

TYPE C—The Fawick Type C Clutch offers the advantage of "free wheeling" where speeds higher than the running speed of the clutch are encountered. Both Types C and E satisfy the severe requirements of slip operation.



HOW IT WORKS

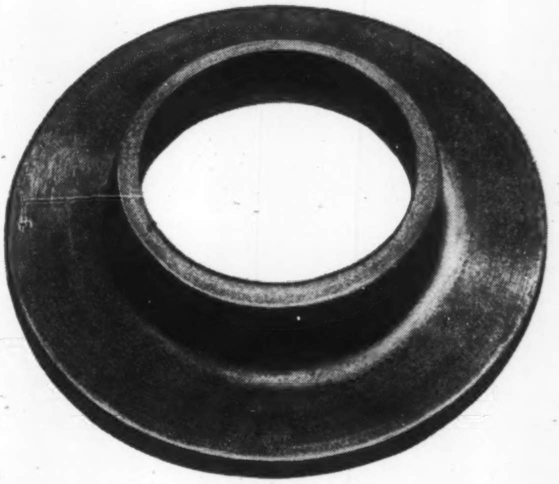
Compressed air expands the rubber-and-fabric gland to engage clutch, any degree of "grip" you need. Release the air and clutch disengages.

FAWICK AIRFLEX CO., INC.
9919 Clinton Road • Cleveland 11, Ohio
In Canada, **Renold-Coventry Ltd., Montreal, Toronto, Vancouver, Quebec**
In Britain, **Crofts Engineers, Ltd., Bradford, England**

FAWICK *Airflex* CLUTCH

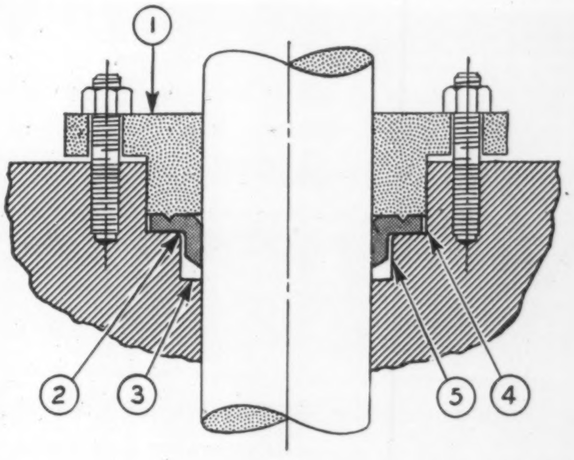
ALEXANDER
FLANGE PACKINGS

(Excerpts from page 7 of our Leather Packing Guide)



If you haven't a copy of the Alexander Leather Packing Guide, send for a copy at once. It is full of valuable data for all users of hydraulic and pneumatic machinery, and is yours for the asking.

On page seven of the Guide you will find a picturization and discussion of the uses of FLANGE PACKINGS with complete descriptions accompanying the mechanical drawing (shown herewith) which illustrates a typical flange assembly—and with recommendations based upon normal installations. You will be pleased to know that on unusual applications, our Engineering Department will gladly advise and recommend without cost.

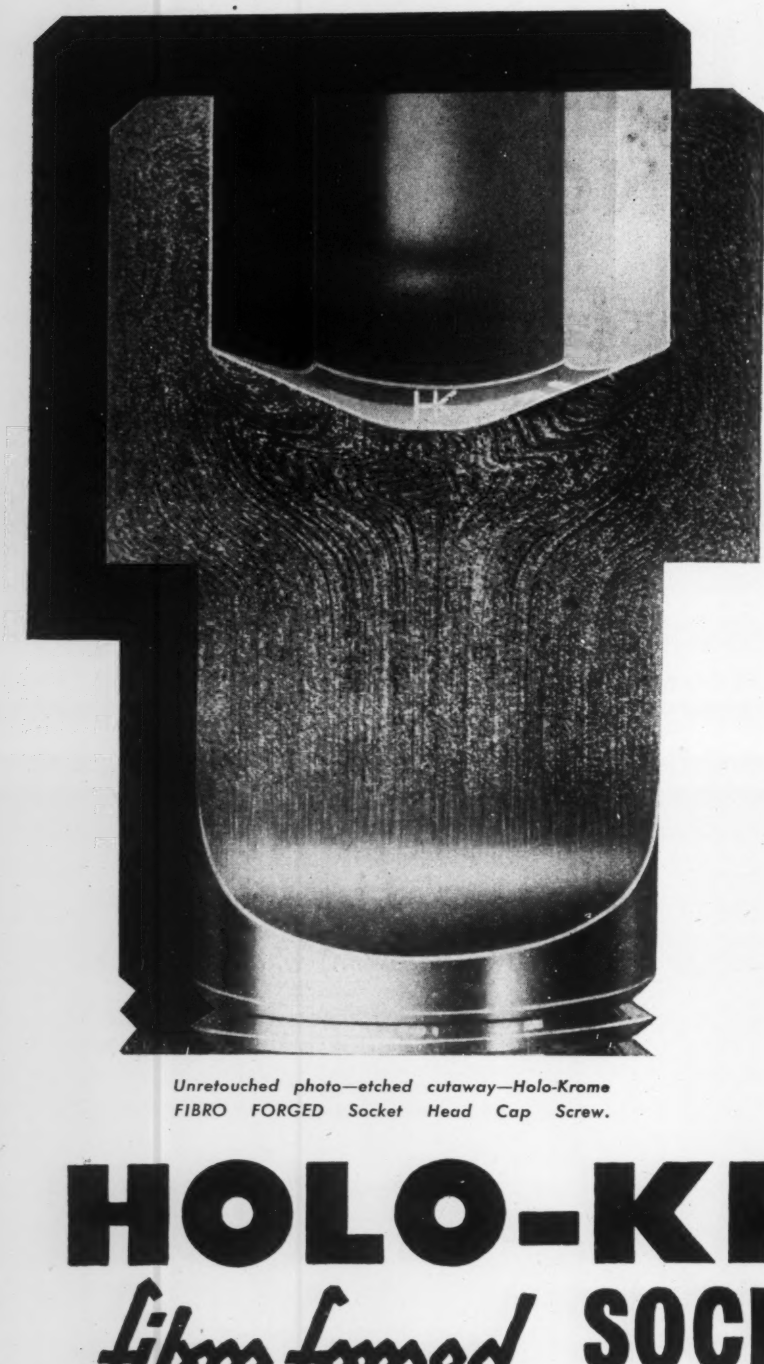


All Alexander Leather Packings are available in various tannages and impregnations designed to withstand the medium and pressure against which each has to operate.

ALEXANDER BROTHERS

406 NORTH 3rd STREET • PHILADELPHIA 23, PA.

Branch Offices: Chicago, Dallas, Charlotte, New York . . . Distributors in Principal American Cities



Unretouched photo—etched cutaway—Holo-Krome FIBRO FORGED Socket Head Cap Screw.

NOTICE THOSE CONTINUOUS FIBRES . . .

COMPLETELY COLD FORGED

Patented Method Owned Controlled Exclusively used by Holo-Krome

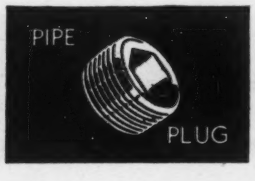
HOLO-KROME

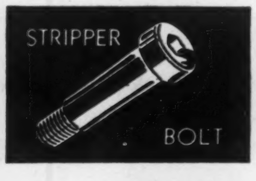
fibro forged SOCKET SCREWS

Continuous Fibres running from end to end! Uninterrupted, unbroken, unsevered! A stronger Socket Screw. This continuous fibrous structure is obtained by Completely Cold Forging — a Holo-Krome patented method.

Yes, when you specify "Holo-Krome FIBRO FORGED Screws", greater strength, uniform quality and accuracy are assured plus the saving of weight, space and assembly time in your production.

THE HOLO-KROME SCREW CORP. HARTFORD 10, CONN., U. S. A





CIRCLE L 12

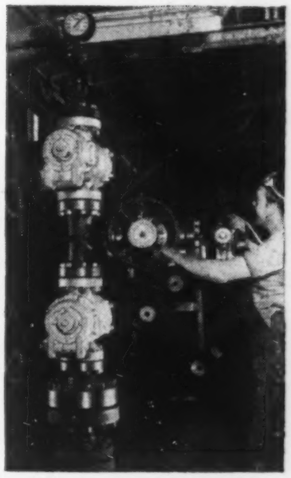
the alloy that meets emergencies

TWO of the best producing oil wells in Terrebonne Parish, Louisiana were shut down—out of production. Gas distillate corrosion had rendered the valves of the Christmas trees unserviceable. The McEvoy Company of Houston, Texas are specialists in corrosion resistant Well Head equipment. They know from experience that Lebanon's Circle Ⓛ 12, is a chromium alloy especially developed for this service and they telephoned us.

Quick work with patterns, molding, pouring, heat treating and finishing made it possible for us to load two of these alloy castings on a plane five days later. (*left*)

Machined by McEvoy, and tested in the assembly (*right*), the finished, corrosion resistant equipment was delivered and the wells were back in operation 8 days after that first emergency phone call.

EASTERN
AIR LINES



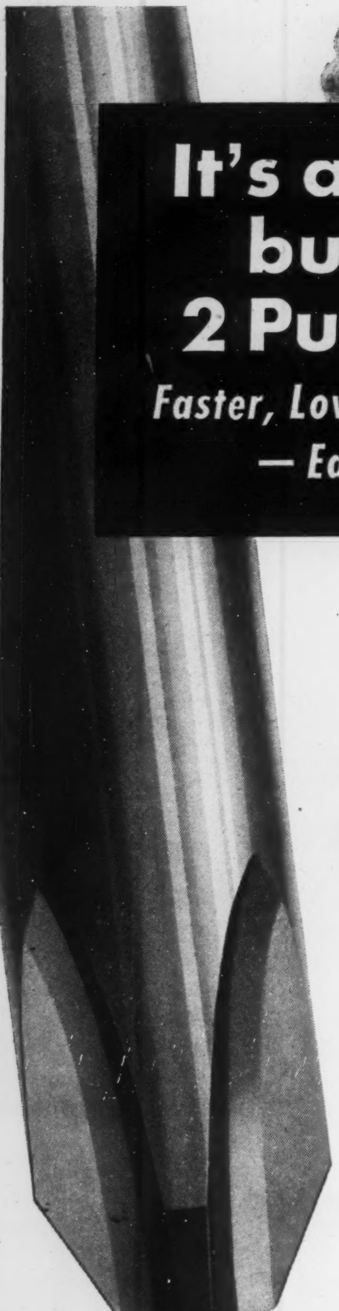
. . . or prevents them

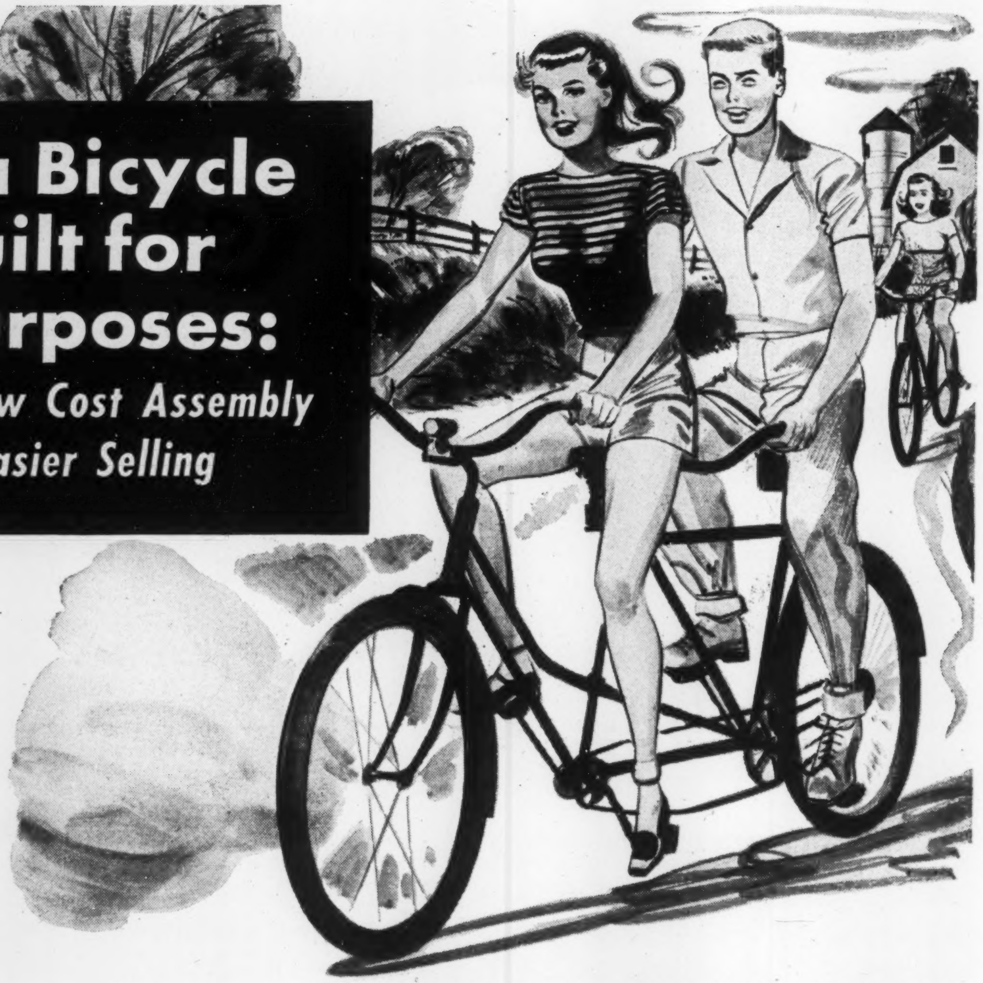
TODAY emergencies due to corrosion failures are unnecessary. Metallurgical progress and modern foundry practices make available a variety of alloys designed for the exact corrosive conditions which are encountered in any particular industry. Our representatives are trained to study the technical details of corrosive conditions in your production equipment. A discussion of these matters is the first step toward preventing shut-down emergencies.

Write for Data Sheet describing in detail the corrosion resistant alloy, Circle Ⓛ 12.

LEBANON STEEL FOUNDRY • LEBANON, PA.
"In The Lebanon Valley"
ORIGINAL AMERICAN LICENSEE GEORGE FISCHER 'SWISS CHAMOTTE' METHOD

Lebanon CIRCLE L ALLOY AND STEEL Castings





It's a Bicycle built for 2 Purposes:

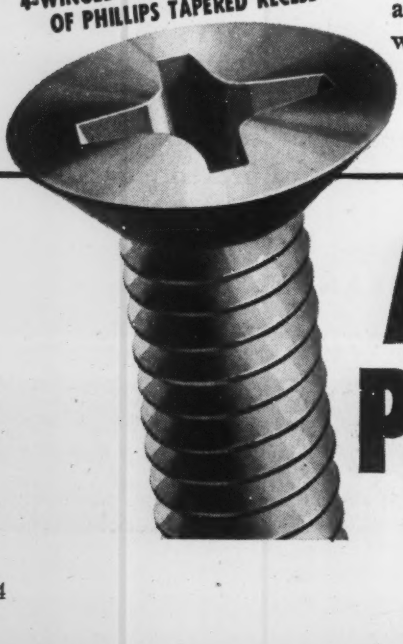
Faster, Low Cost Assembly — Easier Selling

when you use AMERICAN PHILLIPS SCREWS

IN PRODUCTION — Here's the modern way to get the lower costs everyone wants — thru automatic, high-speed screw driving. Screw heads can't burr. Drivers can't slip. Work cannot be spoiled. Fingers can't fumble. And whether you're "buttoning up" bicycles or radios, appliances or airplanes, you cash in on time-savings up to 50%!

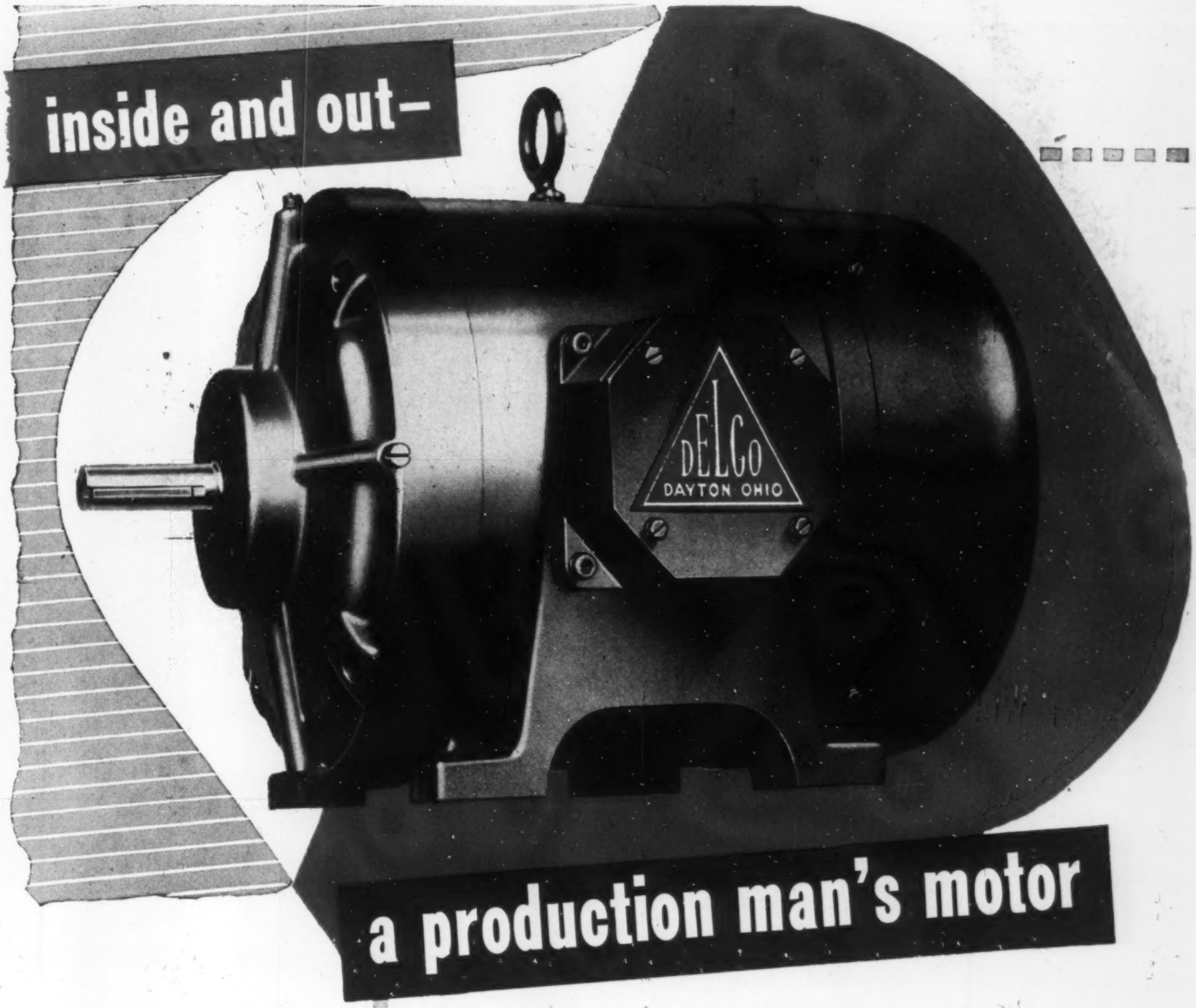
IN PROMOTION — Showmanship and salesmanship *go up* when American Phillips Screws *go in!* They look modern, *are* as modern as this minute. Buyers right down the line — jobbers, dealers, consumers — like their smart looks and the story they clearly tell of long service and solid construction. Write, wire, or phone for these production-promotion advantages today.

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois St. *Detroit 2: 502 Stephenson Building*


4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

AMERICAN PHILLIPS *Screws*

ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)



Standout features of the new

DELCO MOTOR

- Totally enclosed; fan-cooled.
- Individually taped coils.
- Thoroughly insulated windings.
- Unit-cast, ball-bearing rotor, dynamically balanced; parts interchangeable end to end.
- Double-shell frame with new simplified cooling system.
- Extra-large conduit box; can be made watertight by addition of gasket; usable in four 90-degree positions.
- Extended, accessible mounting feet, cast as a unit with main frame.

From its individually taped coils to its totally enclosed frame, the new Delco motor meets specifications for a power source that will keep machine tools humming shift after shift without costly stoppages or troublesome repairs.

The new Delco motor is easier to attach to tools, and usable in four 90-degree positions. It is cooler-running, thoroughly insulated and thoroughly protected against dirt, dust, sand and scale. Only a minimum of maintenance is required, and that is simply and easily performed. From *every* standpoint, this new motor gives production men what they've asked for.

If it's better production *you're* interested in, write for all the data on this great new Delco motor.

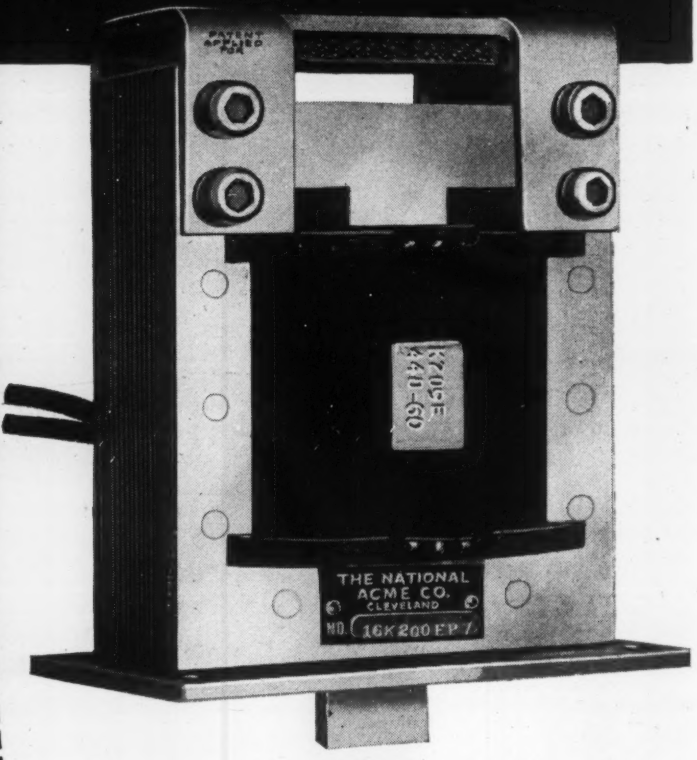
DELCO MOTORS

DELCO PRODUCTS DAYTON, OHIO

DIVISION OF GENERAL MOTORS CORPORATION

DO THESE JOBS *Automatically* WITH NAMCO SOLENOIDS

- Actuate Clutches
- Operate Switches
- Control Machines
- Print Identifying Symbols
- Operate Safety Devices
- Eject Work in Process
- Actuate Clamping Devices
- Move Levers
- Operate Valves
- Vibrate Cutting Knives
- Open and Close Doors
- Hold Chucks
- Open and Close Hoppers
- Sort Inspected Parts



When you want automatic operation—and want it *positive, simplified, compact*—you'll want to investigate Namco Solenoids.

They're *engineered to your specific application*—not just taken off a shelf and shipped to fill an order. We'd welcome the opportunity to recommend the size and style best suited to your job. Ask for Engineering Bulletin EM-46.

The NATIONAL ACME CO.

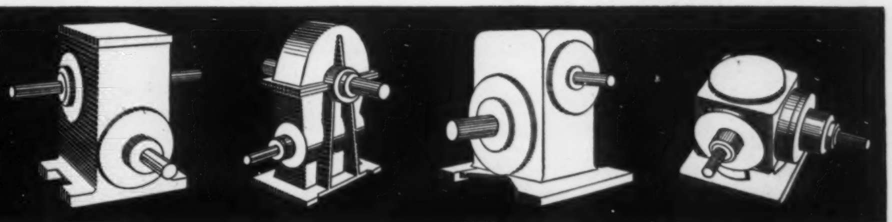
170 EAST 131st STREET • CLEVELAND 8, OHIO

Acme-Gridley Bar and Chucking Automatics: 1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • The Chronolog • Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing

What Speed Reducer shall I use?

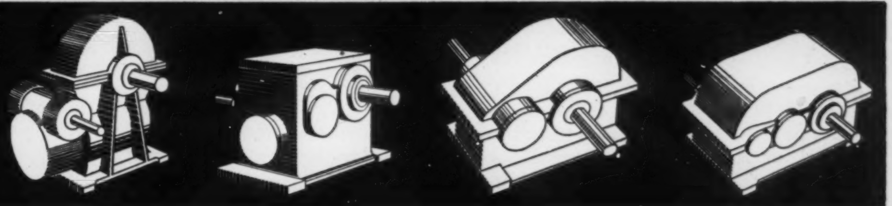
FOR RIGHT ANGLE DRIVES

When you want your driving or motor shaft at right angles with your driven shaft, use any one of these Boston Reductors. Select from these four types depending upon the horsepower or ratio required and the proper type for your application.



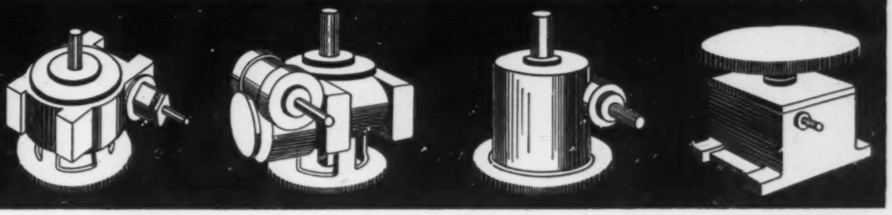
FOR PARALLEL SHAFTS

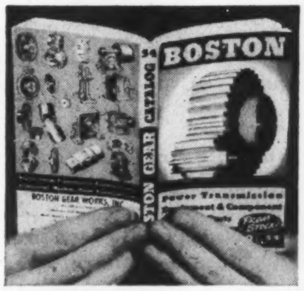
If you desire your driving or motor shaft to be parallel with your driven shaft, use one of these four types. These first two types are double reduction worm and worm gear drives with gear ratios from 16 to 1 as high as 4000 to 1.



FOR VERTICAL DRIVES

You may want a vertical reduction unit for a mixer, conveyor, etc. or where your driven shaft must be vertically up and/or down. These first three types will give you such a versatile drive. The fourth type is strictly a turntable only.





SELECTION A 12-page Reductor or Speed Reducer Selection Chart is included in our General Catalog 54. It contains complete selection data on our Reductors and gives output speeds and gear ratios available, as well as the horsepower motor to use on the Input Shaft of the Reductor. This Selection Chart includes practically all ratios, types and stock sizes available.

DIMENSIONS Complete specifications and dimensions on all Boston Reductors are given in our Catalog 54. If you have a copy of this catalog, you can easily design your drive from the complete dimensions we give you. On some of our Reductors, dimensions are given for elongated Output Shafts which are available as standard assembly. In other cases our speed reducer shafts can project in various other positions as indicated in our catalog.

ORDERING Each and every Boston Reductor has a Catalog Number. No ordering by complicated details after you select whatever ratio, size or type of Reductor you desire. Simply order by Catalog Number.

GENERAL CATALOG If you have need for any speed reduction units in your plant you should have a copy of our 320-page General Catalog 54. It contains complete specifications, dimensions and list prices on all our Power Transmission Equipment and Component Machine Parts — 50 pages of this catalog being devoted to the 12 Reductor types shown above.

BOSTON GEAR WORKS, INC.

NORTH QUINCY 71, MASS.

BOSTON GEAR WORKS, INC., NORTH QUINCY 71, MASS.

Please send me................copies of your General Catalog 54.

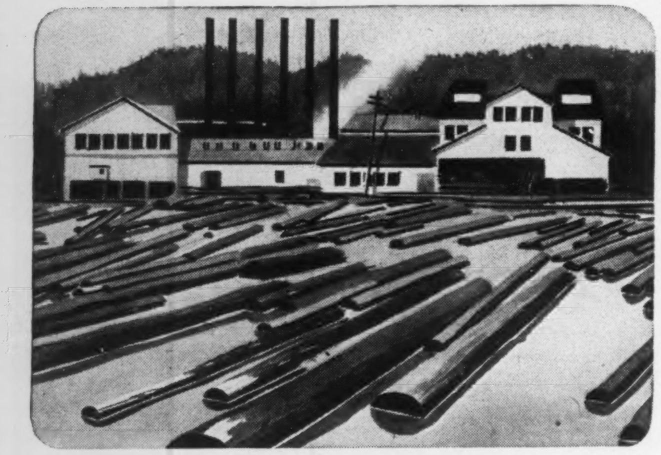
NAME____________________

COMPANY____________________

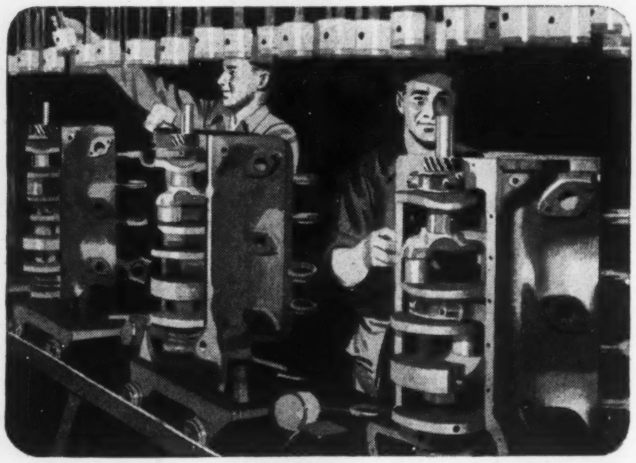
STREET____________________

CITY____________ZONE______STATE________

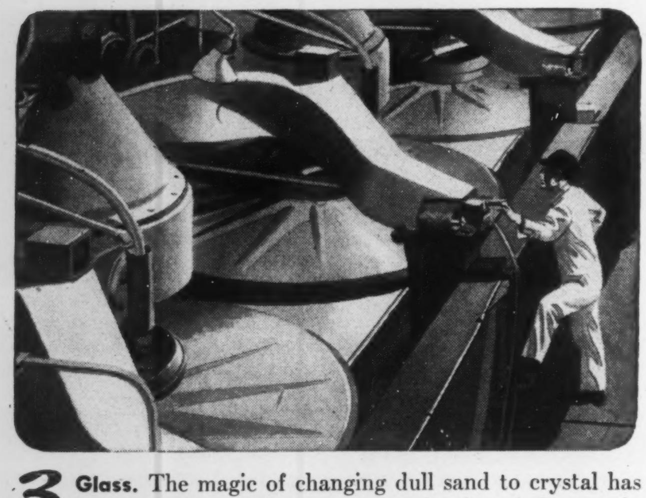
Watch industry Fluid-Drive* ahead!



1 Lumbering. From the land of the tall timber, as well as from the nation's factories, mills and mines, come reports of the extra-efficiency of Gýrol Fluid Drive. Sawmill operators use this simple, compact, adjustable speed device on winches, saws and conveyors. Equipment is protected against the wearing strains of overload.



2 Automotive. In this industry that is synonymous with mass production, minutes means automobiles! Gýrol Fluid Drive saves valuable time by ending shear-pin breakage on conveyors and costly down-time for shear-pin replacement. Engineers find Gýrol Fluid Drive an effective method of evenly distributing load on multi-motored conveyors.



3 Glass. The magic of changing dull sand to crystal has built another giant mass production industry in America. Gýrol Fluid Drive plays an important part in glass making by furnishing adjustable speed control for fans used in manufacturing processes.

4 And You? Gýrol Fluid Drive has spread rapidly through American industry. Currently, more than 7½ million horsepower (exclusive of automobiles) are driven through Gýrol Fluid Drive. But we believe this is *only the beginning* of the potential applications.

For your own business, consider these features:

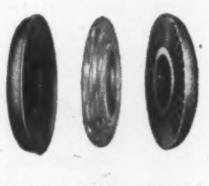
Smooth starts, under load, without strain on equipment —assurance against shear-pin breakage.

Stepless adjustable speed control with standard constant speed AC motors—in a compact convenient form.

Quite possibly, investigation will show several profitable uses for Gýrol Fluid Drive in your plant, product or processes. Why not discuss the matter with one of our representatives? Call or write the nearest American Blower Branch Office for a presentation of Gýrol Fluid Drive.

For better performance get—

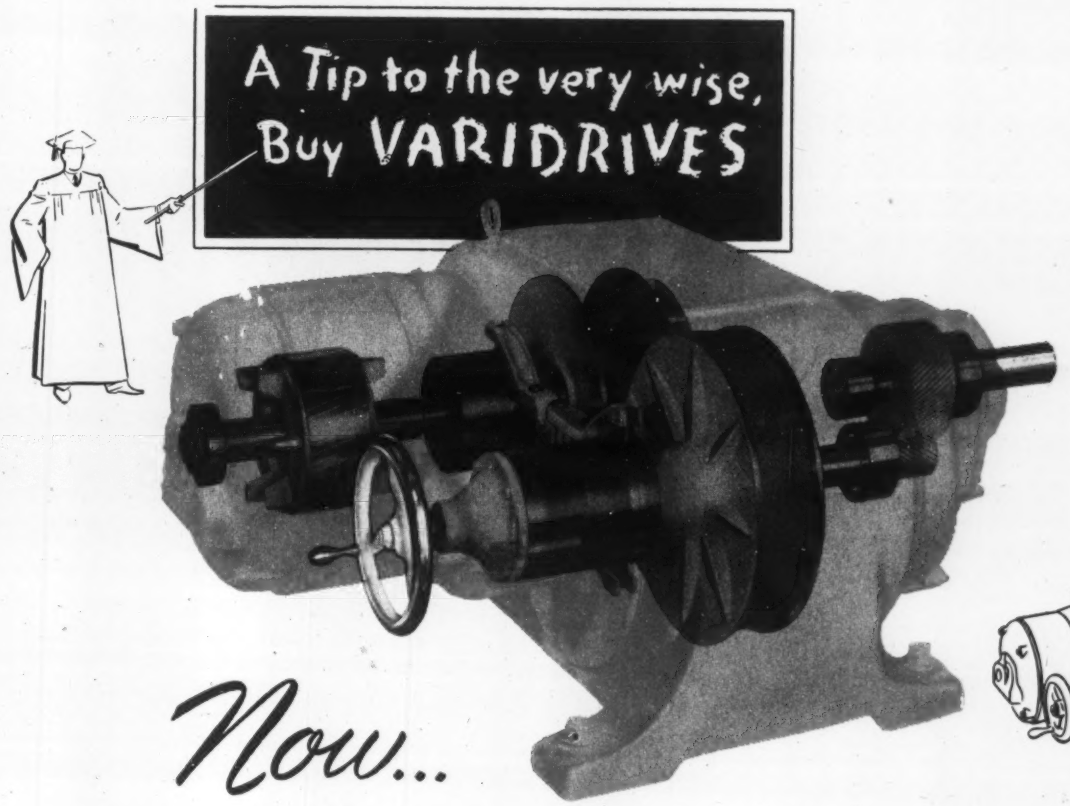
GÝROL *Fluid Drive*

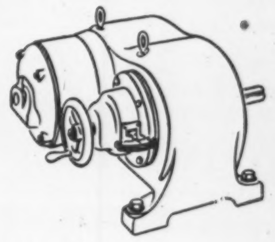


* *Gýrol Fluid Drive is a product pioneered and developed for American industry by American Blower. It is designed for applications where smooth transmission of power or stepless adjustable speed control is desired. Looking beyond the long list of applications already developed, we should like to work with you to find new ways to "Fluid-Drive Ahead!"*

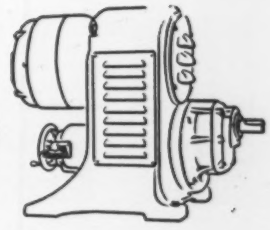
AMERICAN BLOWER

DETROIT 32, MICHIGAN
In Canada: CANADIAN SIROCCO CO., LTD., Windsor, Ont.
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION





Now...



for a few dollars more you can have *Varidrive* instead of a fixed speed motor

When you select your next motor, pause for a moment and think of all the extra advantages variable speed will give to your machine.

It may surprise you to learn that you can now buy a *U. S. Varidrive Motor* for not too many dollars more than an ordinary motor will cost. But the savings it will return to you will pay and repay this small difference in cost for years to come in many ways.

A *Varidrive* does more than give you thousands of speeds. It gives you precise control that fits the operator's rhythm of movement. It will help synchronize production flow. Your machine will produce more because you can regulate its speed instantly to meet the varying conditions that arise day to day, hour to hour, minute to minute. You'll get more output from your shop labor—a better "frame of mind," less fatigue, complete satisfaction on his part,—because he will be operating with the best for the job.

The *U. S. Varidrive Motor* helps modernize your plant. It's the last word in motor power. It's compact, self-contained, occupies little more space than an ordinary motor—and it enables your present equipment to operate with more scope, at controlled tempo.

If you have never used a *U. S. Varidrive* you can't realize the uplifting effect it has upon the operator, as well as the increased versatility it gives to the driven machine. *So try one.* Put it through the paces. You'll be amazed at what it will accomplish. And bear in mind, its initial cost is little more than just a motor. You can't afford to operate without it.

Speed ranges up to 7 to 1. H. P. ¼ to 15. Built-in gearing available for lower speeds.

Ask for Bulletin F-836

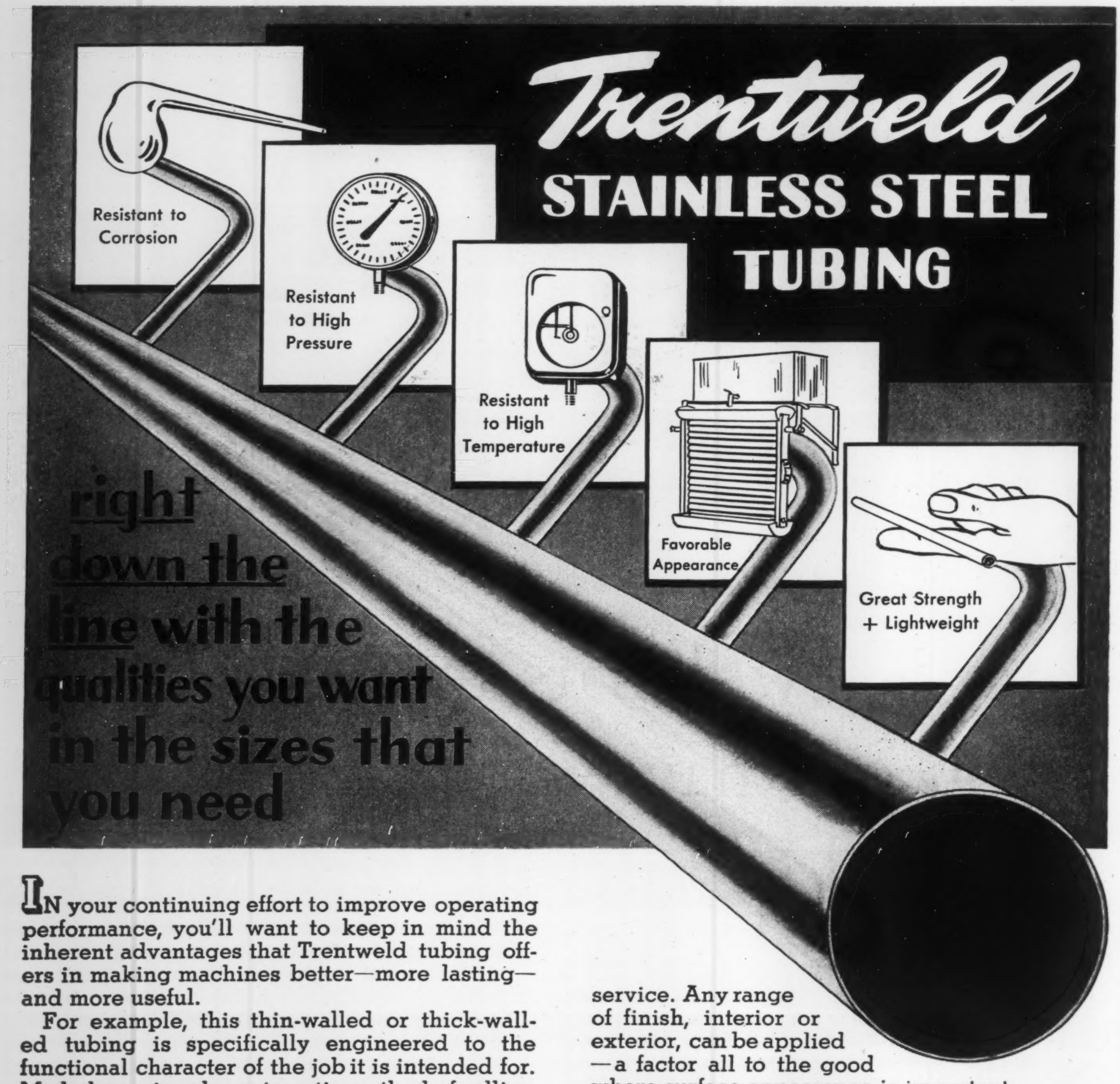
U.S. ELECTRICAL MOTORS Inc.

Atlantic Plant: Milford, Connecticut
Pacific Plant: Los Angeles 54, California

District Offices: Boston 16—New Yo
City 6—Philadelphia 2—Pittsburgh 22—
Chicago 8—San Francisco 7—Seattle 4

Sales and Service offices in all principal cities

Trentweld
STAINLESS STEEL TUBING


Resistant to Corrosion
Resistant to High Pressure
Resistant to High Temperature
Favorable Appearance
Great Strength + Lightweight
right down the line with the qualities you want in the sizes that you need

IN your continuing effort to improve operating performance, you'll want to keep in mind the inherent advantages that Trentweld tubing offers in making machines better—more lasting—and more useful.

For example, this thin-walled or thick-walled tubing is specifically engineered to the functional character of the job it is intended for. Made by a singular automatic method of rolling and welding, this new, advanced tubing, in thin-walled or thick-walled form, is unusually uniform in composition and structure. Pickling and annealing operations are precisely controlled and adjusted to the end application of the tubing. The net result is a fine-grained metal—stainless steel or Inconel—so homogeneous, so completely free from inclusions, so especially treated for severe industrial requirements, that it has far more than an ordinary capacity for service. Any range of finish, interior or exterior, can be applied—a factor all to the good where surface appearance is important.

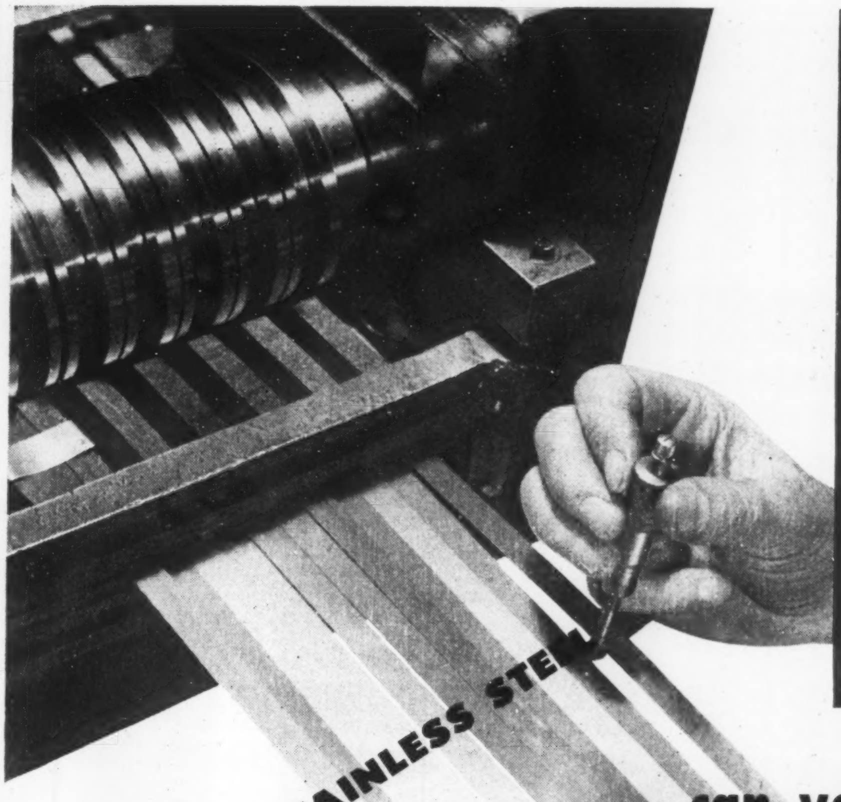
For these reasons and many more, Trentweld tube, in diameters from 1/8" to 24", is being used today by many top-ranking American manufacturers. Feel free to call on Trentweld engineers—as others have—to put a shoulder to the wheel on any application you have in mind. Draw on their wide experience without obligation. Address—Department 21 or write for the Trentweld Data Bulletin.

TRENTWELD
STAINLESS
STEEL
TUBES

Sales Office—664 N. Michigan Avenue, Chicago 11, Illinois

TRENT TUBE MFG. CO.

Mill at East Troy, Wisconsin



● With competition for the consumer dollar stiffening, alert fabricators are growing increasingly aware of the profit and production advantages of CMP Stainless Thinsteel. Many are already cashing in on this precision material . . . others may be missing a good bet in neglecting to check its possibilities.

can you apply these 10 advantages to your product?

- Unvarying coil-after-coil dimensional accuracy, physical properties and chemistry.
- Corrosion resistant and heat resistant properties inherent in various grades.
- Wide range of physicals and analyses — tailored for your job.
- Extremely close tolerances — for more parts per ton.
- Extra long coils — for less downtime, more efficient production.
- Superior surface finish cuts finishing costs.
- Gauges thin as .001" — for lightness with strength.
- Quick mill shipment to keep your production lines running.
- Eye-appeal that gives your product greater sellability.
- The product of a specialist — for CMP produces *only* cold rolled strip steel.

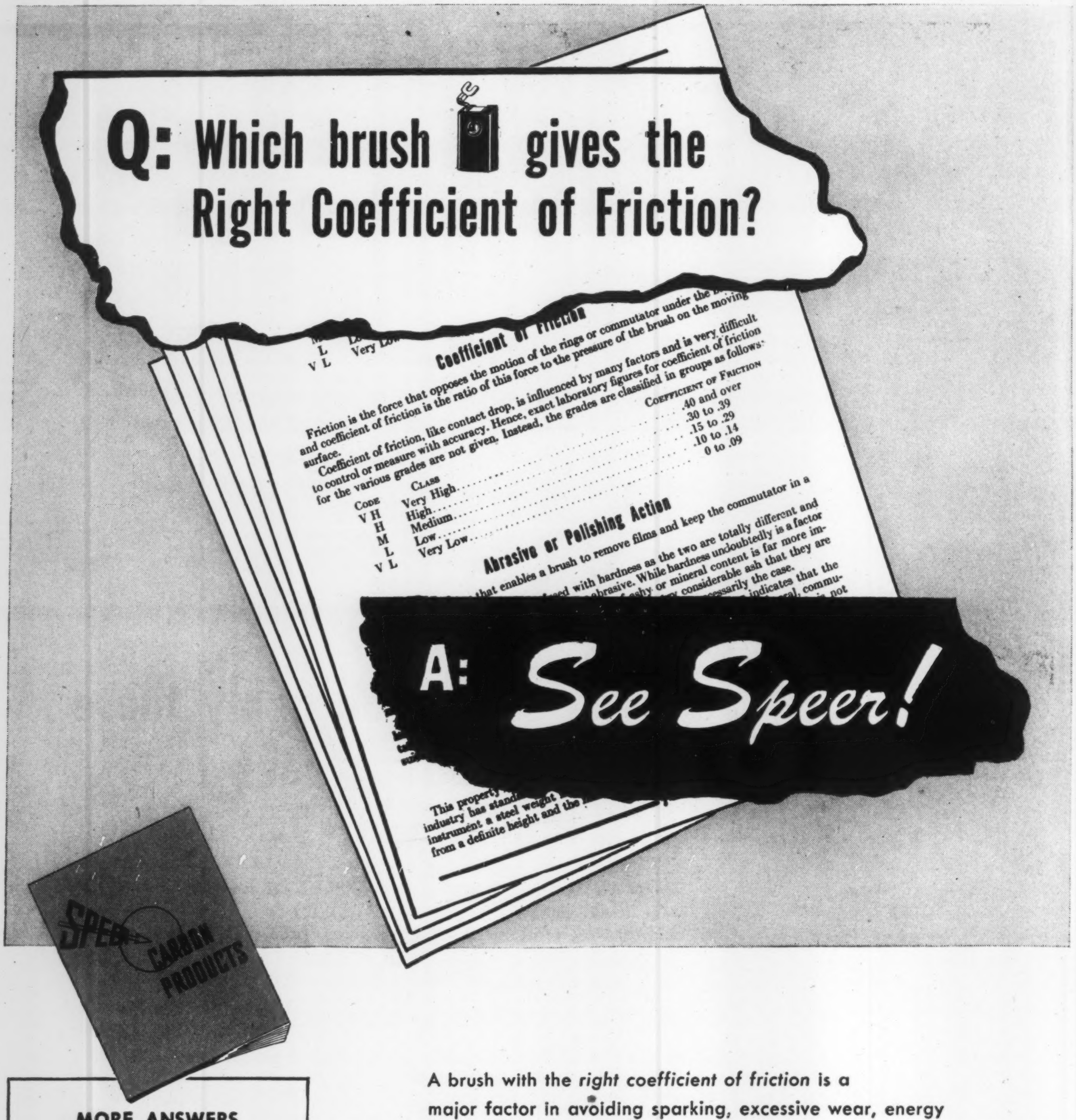
●

- Write, wire or phone CMP today.

THINSTEEL

CMP STRIP STEEL
PRECISION COLD ROLLED
GIVES MAXIMUM PRODUCTION PER TON

THE COLD METAL PRODUCTS CO.
YOUNGSTOWN 1, OHIO
Sales Offices
NEW YORK • CHICAGO • DETROIT • ST. LOUIS
BUFFALO • DAYTON • LOS ANGELES


Q: Which brush gives the Right Coefficient of Friction?
A: See Speer!
SPEER CARBON PRODUCTS

L Very Low
V L

Coefficient of Friction

Friction is the force that opposes the motion of the rings or commutator under the br and coefficient of friction is the ratio of this force to the pressure of the brush on the moving surface.

Coefficient of friction, like contact drop, is influenced by many factors and is very difficult to control or measure with accuracy. Hence, exact laboratory figures for coefficient of friction for the various grades are not given. Instead, the grades are classified in groups as follows:

Code	Class	Coefficient of Friction
V H	Very High	.40 and over
H	High	.30 to .39
M	Medium	.15 to .29
L	Low	.10 to .14
V L	Very Low	0 to .09

Abrasive or Polishing Action

that enables a brush to remove films and keep the commutator in a
fused with hardness as the two are totally different and
abrasive. While hardness undoubtedly is a factor
ashy or mineral content is far more im-
considerable ash that they are
necessarily the case.
indicates that the
general, commu-
is not

This property
industry has standa
instrument a steel weight
from a definite height and the

MORE ANSWERS in this book. Get it!

This catalog, *SPEER CARBON PRODUCTS*, gives detailed information on brush characteristics, includes Speer Brush Data Sheets. It answers your questions on brush selection, helps you find the right brush for your motors or generators!

A brush with the *right coefficient of friction* is a major factor in avoiding sparking, excessive wear, energy loss, burning, overheating, and other brush troubles. Many complicating factors, difficult to define, enter into the selection of a brush with this important characteristic properly matched to operating conditions of each commutating or slip ring machine.

Let Speer help you select the brush with the right coefficient of friction to meet your particular requirements. In fact, the Speer brush recommended for your use will combine *all* the right characteristics for your specific operating conditions. That's why Speer brushes bring satisfaction wherever they're installed.

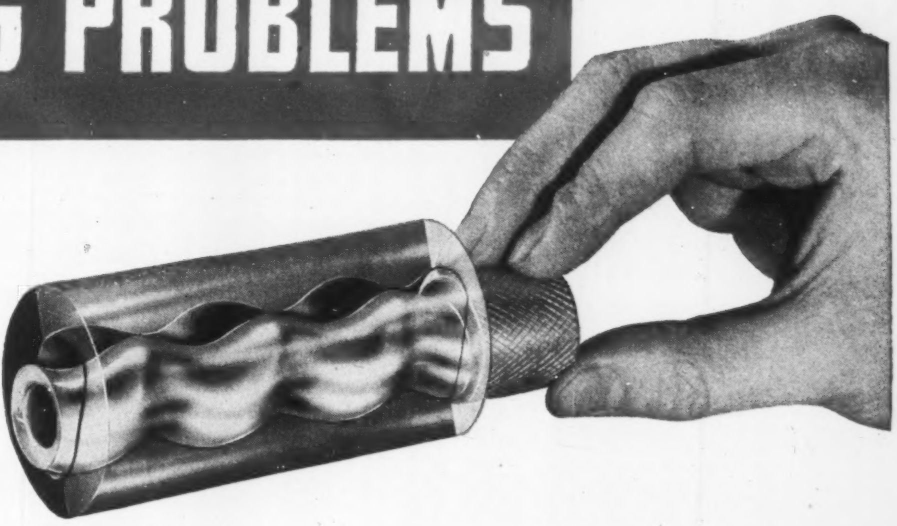
2549

SPEER
Speer
CARBON COMPANY
ST. MARYS, PENNA.

brushes · contacts · welding electrodes · graphite anodes · rheostat discs · packing rings · carbon parts

CHICAGO · CLEVELAND · DETROIT · MILWAUKEE · NEW YORK · PITTSBURGH

LICKS PUMPING PROBLEMS



Pumps Practically *Anything* from Liquids to Non-Pourable Pastes

If it will push through a pipe, you can *move* it with an R&M Moyno—the amazing helical-rotor pump that passes particles, resists chemical reaction, delivers positive pressure without pulsation...*stands up* where other pumps *fail.* From clay slip to corn syrup, from gasoline to glue, here's the *answer* to your pumping problems.

"Like a rope flipped up and down in a long slot," said one Plant Engineer describing unique Moyno rotary motion. Rotor and stator work together to form *ever-changing,* progressing seal lines with voids between which carry the material. Reversing rotation reverses flow. *Thousands* are in use on all types of services.

Typical Materials Handled

Anhydrous Ammonia
Animal Blood
Beer
Brewer's Yeast
Carbide Sludge
Cellulose Solutions
Chemicals
Citrus Juices
Clay Slip
Cold Cream
Corn Syrup
Distiller's Slop
Dog Food
Enamel
Fuel Oil
Gasoline
Glucose
Glue, Water Glass
Greases
Hash
Liquefied Gases
Tool Coolant
Magnesium
Marshmallow
Milk, Cream
Molasses
Mud (oil well)
Oils
Paper Stock and Coatings
Paints
Plastics
Porcelain
Pulp (fruit and vegetable)
Putty
Resins, hot
Rubber Cement
Sand, Silt
Sludge, Slurries
Solvents
Starches
Tar
Tooth Paste
Water (sweet, salt)
Wine (including stems, seeds, sediments)

The Pump Without "Type" Limitations

MOYNO vs. Piston Pump

Moynos have no valves; no pulsation; less weight, bulk; better performance on highly viscous fluids; much longer life on abrasives; usually, lower cost.

MOYNO vs. Centrifugal

Moynos are self-priming; liquid velocities are low, smooth, uniform; displacement is positive. Moynos give better capacity-pressure regulation; can create higher reserve pressures; pump highly viscous fluids better, and with less wear.

MOYNO vs. Rotary

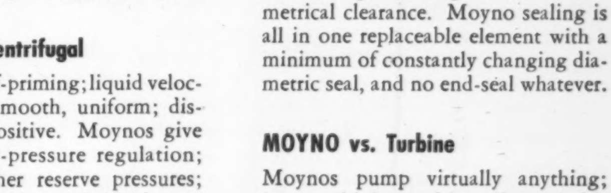
Moynos are not limited to moderate pressures and to services only mildly abrasive; do not depend upon critical end-sealing and large areas of diametrical clearance. Moyno sealing is all in one replaceable element with a minimum of constantly changing diametric seal, and no end-seal whatever.

MOYNO vs. Turbine

Moynos pump virtually anything; have no high-speed impellers or critical clearances; handle abrasives.

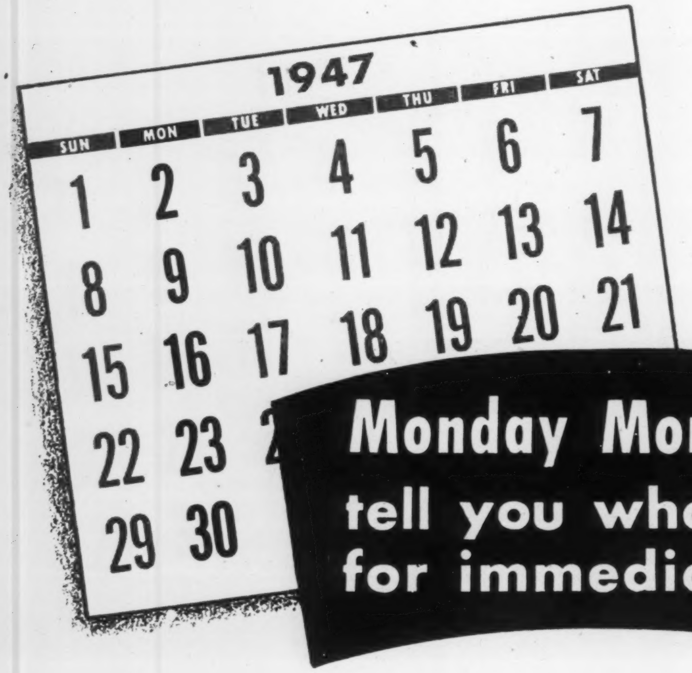
Find Out About Moyno Pumps, NOW!

If you use pumps, or ever expect to, you should know about the R & M Moyno. It's the *one* pump that "does everything" well. Types for general service; for higher pressures (up to 1000 p.s.i.); for liquefied gases; for food-type products; and for specialized service needs. Our new book, "A Turn for the Better...," tells the whole interesting story. Write today. Distributors from coast to coast.


A Turn for the Better
R&M MOYNO PUMP

ROBBINS & MYERS • INC. MOYNO PUMP DIVISION • SPRINGFIELD, OHIO
In Canada: Robbins & Myers Co. of Canada, Ltd., Brantford, Ont.

MOTORS • HOISTS • CRANES • MACHINE DRIVES • FANS • MOYNO PUMPS • FOUNDED 1878



Monday Morning Stock Lists

tell you what's available for immediate shipment...

MAINTAINING a substantial stock of Ross Standard "BCF" Coolers as "shelf goods" is a natural outgrowth of the steady, widespread demand for these small, light weight units.

Each Monday morning all Ross offices and representatives receive a fresh stock list showing the size and quantity of "BCF" Coolers available for shipment within 24 hours following receipt of orders in Buffalo. (Sometimes shipments can go forward the same day, if urgently needed.)

So, for oil, water and other fluid cooling that requires a compact, efficient unit, check with your nearest Ross representative about the standard "BCF" line. He can tell you not only what sizes are immediately available and in what quantities, but will quote you costs from published price and discount lists.

ROSS "BCF" COOLERS

Ross equipment is manufactured and sold in Canada by Horton Steel Works, Ltd., Fort Erie; Ontario.

☆ For design details of Ross "BCF" Coolers, write for Bulletin 4922 on your Company letterhead.

Ross Heater & Mfg. Co., Inc. Division of American Radiator & Standard Sanitary Corporation **1429 West Ave., Buffalo 13, N.Y.**

When "Designing for Durability"

KENNAMETAL

Kennametal—the new and distinctive metal having a high degree of hardness, strength, and wear resistance—deserves consideration in the blueprint stage of your product. Properly applied, it gives superior service under heavy duty use, where conditions of wear, strain, heat, and shock are destructive to other metals.

By providing for Kennametal in your original design—your product actually may cost less to produce with Kennametal, then it does without it. Here's why . . .

The incorporation of Kennametal at friction and bearing points in your basic design may make possible a more compact, simplified, lighter weight component that requires less of other materials, and a minimum amount of Kennametal.

Kennametal often makes feasible the development of useful new machines and equipment that have been pigeon-holed because of the short life of construction materials previously available. It is the metal to remember . . . when you are "Designing for Durability."

Our engineers and metallurgists will be glad to cooperate with you. Remember . . . Kennametal can be used without entering into any complicated, continuing agreements.

NNAMETAL
ERIOR CEMENTED CARBIDES
KENNAMETAL *Inc.*, LATROBE, PA.

KENNAMETAL
WEAR-RESISTANT CHARACTERISTICS

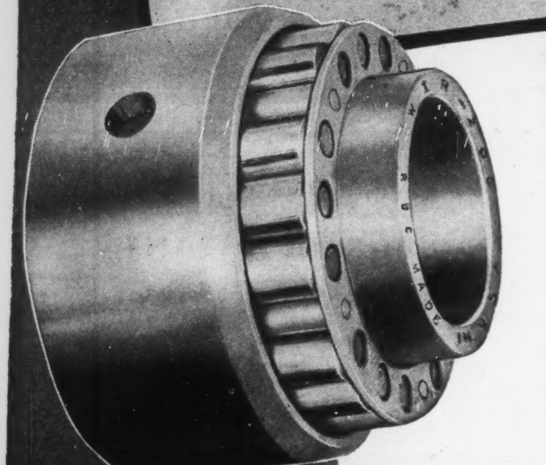
- Abrasion resistance up to 100 times that of steel. Rockwell C hardness up to 80.6 as compared to 66 maximum for hardened tool steel.
- Non-galling. Low frictional resistance between Kennametal and steel, or other materials, minimizes galling of parts from rubbing contact.
- Dimensionally stable. Low rate of thermal expansion—"creep" is negligible.
- High resistance to deformation. Modulus of elasticity is 2 to 3 times that of steel.
- Great compressive strength. Resistance to crushing is higher than that of virtually all melted and cast or forged metals and alloys.
- Heat-resistant. Cutting tool compositions regularly resist 1200° to 1500° F. Special compositions resist up to 1800° F, in oxidizing atmosphere; much higher temperatures in non-oxidizing atmosphere.

Le TOURNEAU *Insists* on

RBC *Solid Roller* BEARINGS

for this HIGH-SPEED RUBBER-TIRED Tournadozer

New model C Tournadozer, the latest addition to the ingenious LeTourneau line of rubber-tired earth-moving and construction equipment.



Heavy Duty
Solid Roller Bearing
200-300 Series

In those applications that require a cage to guide the rollers, such as in the transmission and sheaves of this Model C Tournadozer, the **RBC** 200 and 300 Series offer unbelievable strength.

1947
MACHINE
CHICAGO
SEPT 17-26
TOOL
SHOW

The SOLID ROLLERS are grouped to provide the maximum number of load-carrying elements and are made of SAE 52100, the same fine bearing steel that is used in the races and in the companion lines—the CYCLOPS and 20TH CENTURY.

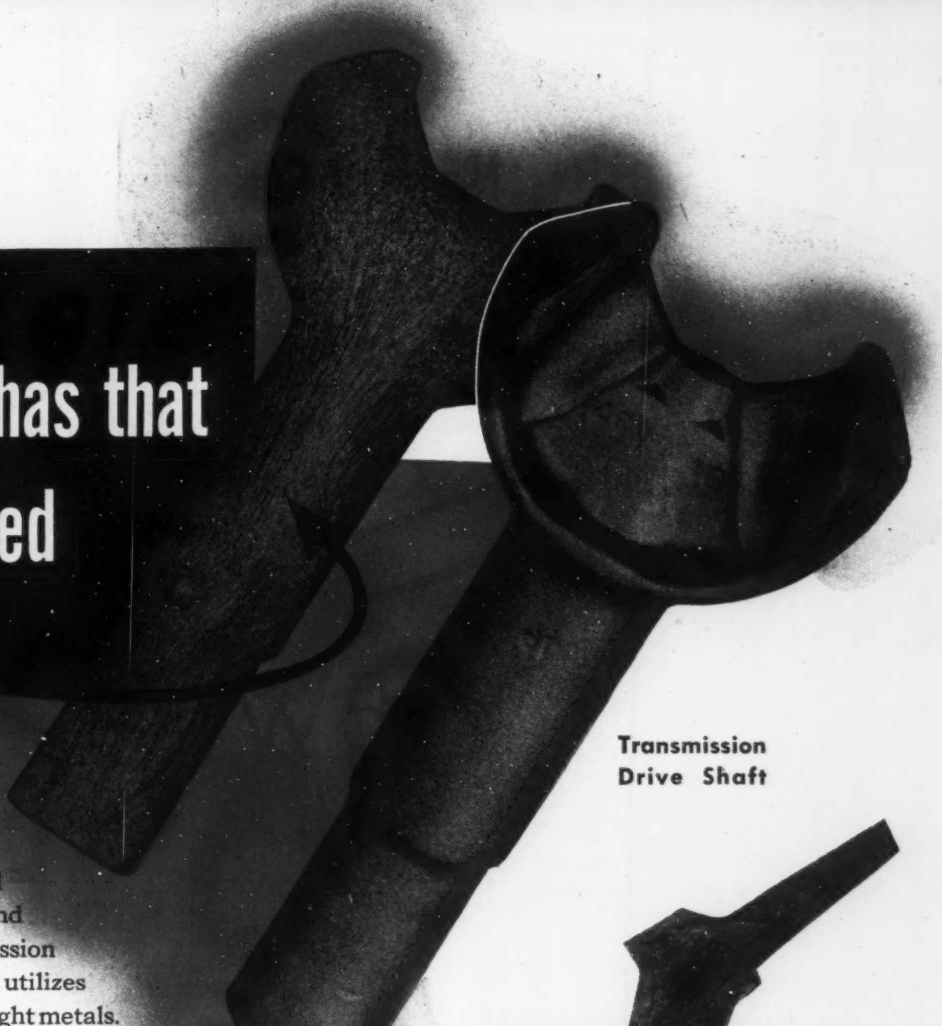
Increase the efficiency of the Machines you design. Write us— **RBC** Engineers will be glad to assist you.

ROLLER BEARING CO. OF AMERICA
TRENTON, NEW JERSEY

What a *Forging* has that can't be duplicated

Muscles! Muscles of steel—the fiber-like flow line structure inherent in wrought metals which is directioned, controlled and concentrated at points of greatest shock and stress by forging metal in closed impression dies. No other method of fabricating parts utilizes fully the fiber-like flow line structure of wrought metals.

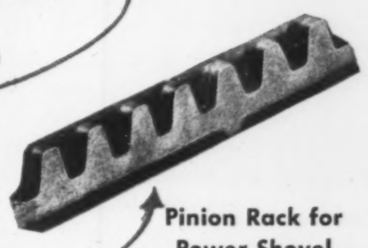
Forgings reduce parts failures and protect you and your customer from unpredictable emergencies. Forgings provide rapid assembly of complex parts by welding adaptability of widest range; forgings permit reduction of dead weight because maximum strength and toughness is obtainable in lighter sectional thicknesses. There is no substitute for the metal quality and cost reducing advantages of forgings. A recheck of every stressed part, as well as simple handles and levers, frequently reveals opportunities to improve a product, to reduce the cost of machining and finishing, to speed up assembly. Consult a forging engineer while the part is in the design stage because it is important that the design utilize fully the fiber-like flow line structure obtainable in forgings—muscles of steel that can't be duplicated.



Transmission Drive Shaft

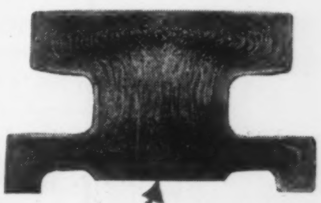
Oil Well Drilling Tool Part

What a *Forging* has that can't be duplicated



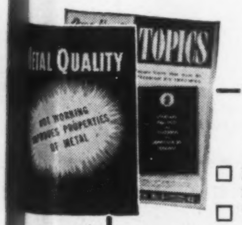
Pinion Rack for Power Shovel

What a *Forging* has that can't be duplicated



Gear Blank for Truck Transmission

What a *Forging* has that can't be duplicated



METAL QUALITY
HOT WORKING IMPROVES PROPERTIES OF METAL
TOPICS

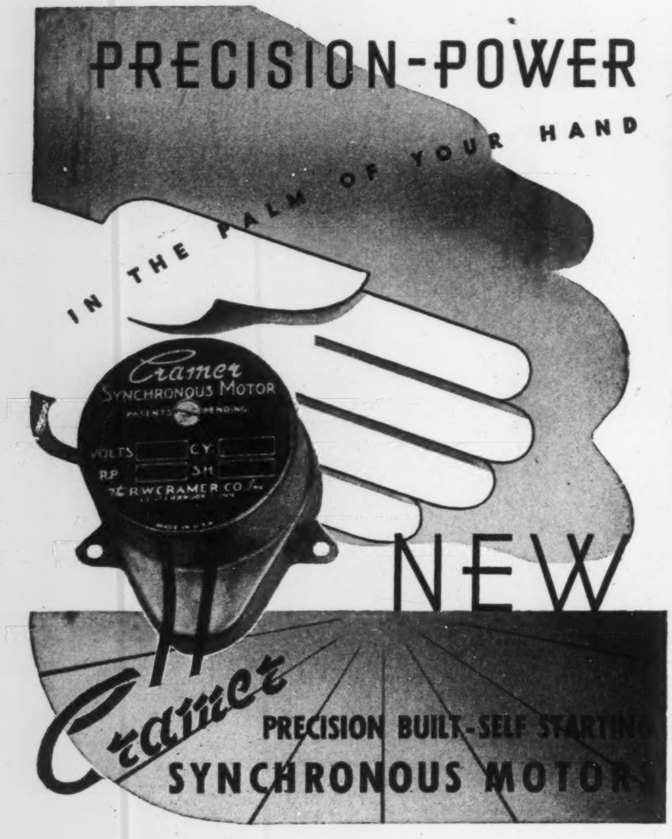
DROP FORGING ASSOCIATION
605 Hanna Building • Cleveland 15, O.

☐ Booklet on "Metal Quality – Hot Working Improves Properties of Metal."
☐ "Drop Forging Topics."

Name .... *Position* ....
Company ....
Address .... *City* .... *State* ....

DROP FORGING ASSOCIATION

605 HANNA BUILDING • CLEVELAND 15, OHIO


PRECISION-POWER
IN THE PALM OF YOUR HAND
Cramer
Synchronous Motor
Patents Pending
VOLTS
CY
RP
SH
R.W. CRAMER CO. Inc.
Made in U.S.A.
NEW
Cramer
PRECISION BUILT-SELF STARTING
SYNCHRONOUS MOTORS

WITH THESE SPECIFIC POINTS OF DESIGN AND PERFORMANCE SUPERIORITY

- Small Physical Size—2⅜ x 2⅛ x 1½.
- Extremely High Torque—30 in. ozs. at 1 r.p.m.
- Low Input—2.7 watts at 115 or 230V. 60 Cy.
- Average Heat Rise—30°C at rated voltage.
- Low Rotor Speed—240 r.p.m. at 60 Cy.
- Precision Cut—interchangeable gear trains.
- Twenty-eight Speeds—60 r.p.m. through 1/24 r.p.h.
- Ample sealed in Lubricant.
- Removable Coils.
- Runs in any position.

Designers and builders of high grade instruments . . . including ourselves . . . have long looked for a real precision built motor combining the above important features and performance characteristics. This new Cramer Self-starting Synchronous Motor is exactly what you have been looking for. 60 cycle available now, later production also planned on 25 and 50 cycle. Write us at once for further details outlining your specfic requirements.

THE R. W. CRAMER COMPANY
Box No. 6, Centerbrook, Conn.

Cramer

SPECIALISTS IN AS A FACTER OF **TIME CONTROL**

INTERVAL : DELAY : CYCLE : IMPULSE : PERCENTAGE

BY JOVE, WATSON, THIS TRACING CLOTH DOES HAVE ERASURES... BUT YOU'D NEVER KNOW IT!

HERE'S ERASABILITY WITH A CAPITAL "E" FOR EXCELLENCE

Sherlock Holmes seldom made mistakes. Maybe you don't, either, but it's good to know that when you *want* to erase, you *can* on PEL-X Water Repellent Tracing Cloth — without detection!

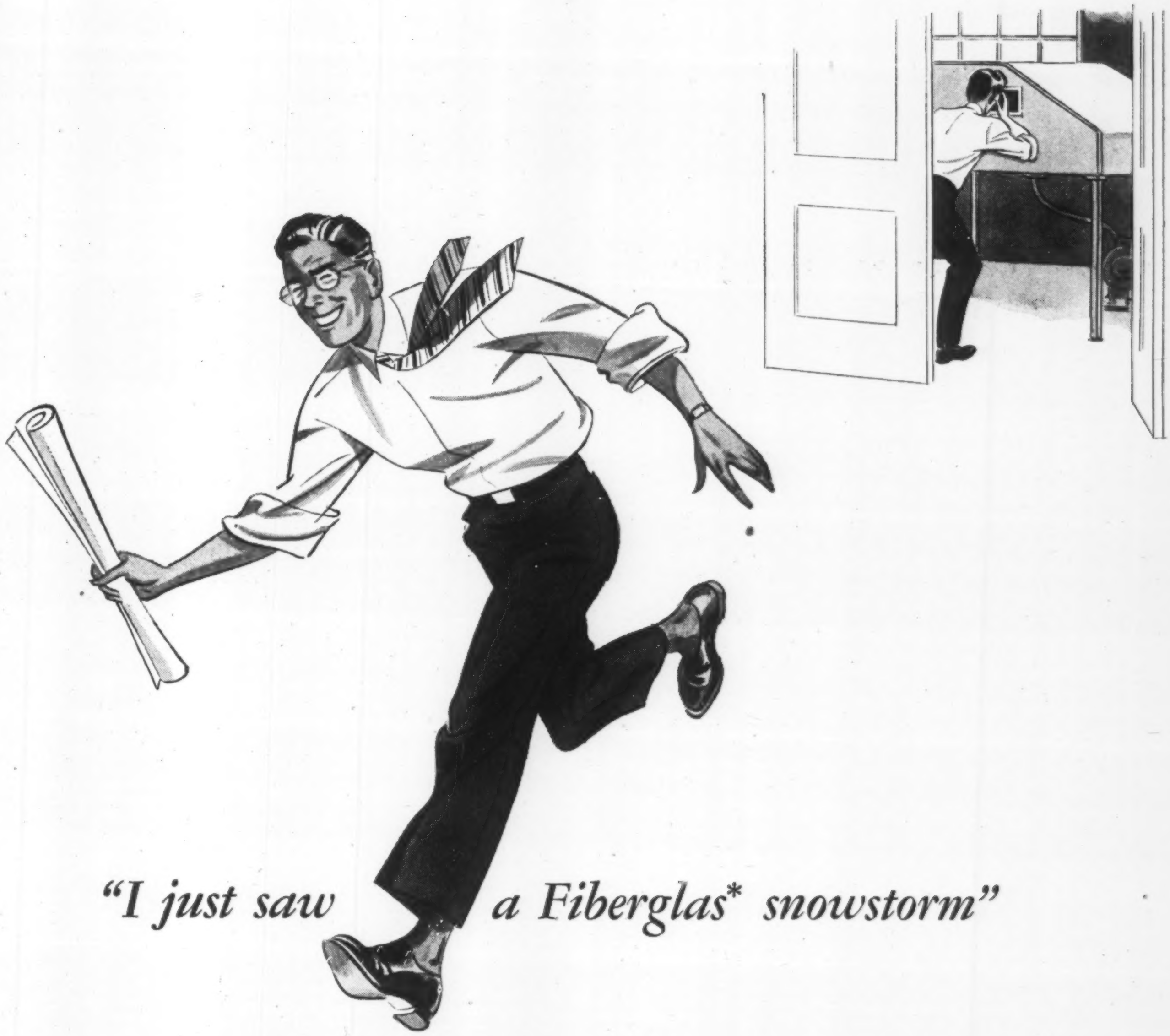
Rugged resistance to repeated erasure is only part of the story. You also get cleaner, sharper reproductions, true to scale and free from feathered lines, fog or cloudiness. *And* you get this more quickly, with less eye-strain — because PEL-X is truly *transparent.* Ask your dealer for PEL-X today!

FOR BETTER PLANS...
Better Plan on PEL-X Tracing Cloth.

WHITE PENCIL
PEL-X
WATER REPELLENT
TRACING CLOTH

Current Holliston Production includes: TRACING CLOTHS, COATED and IMPREGNATED FABRICS, INSULATING CLOTH BASE, SEPARATOR CLOTHS, MAP CLOTH, PHOTO CLOTH, REINFORCING FABRICS, SIGN LABEL and TAG CLOTHS, BOOKBINDING CLOTHS, SHADE CLOTH.

THE HOLLISTON MILLS, INC.
CHICAGO Norwood, Mass. NEW YORK



"I just saw a Fiberglas snowstorm"*

He has seen more than that. He's seen an important step in a new, economical, high-speed method of mass producing plastics products, *reinforced with Fiberglas fibers*. . . The "snowstorm", blown fiber, preform process converts short strands of Fiberglas into a preform having the approximate shape and dimensions of the finished part. The preform is then placed into a heated mold and, with the addition of resin and application of pressure, is converted into a finished part. This process permits the production of "deep-drawn" shapes without drawing . . . Investigate this production process. It may solve some of your problems. Find out about the various forms in which Fiberglas is furnished for plastics reinforcement —Fiberglas has a combination of desirable characteristics found in no other material.

WRITE FOR SAMPLES of Fiberglas "snowstorm" fibers, T-36 mat, or ask for a copy of the new booklet describing all Fiberglas reinforcing materials and illustrating the new quantity production methods. Owens-Corning Fiberglas Corporation, Dept. 808, Toledo 1, Ohio. Branches in principal cities.

In Canada: Fiberglas Canada Ltd.

OWENS-CORNING

FIBERGLAS

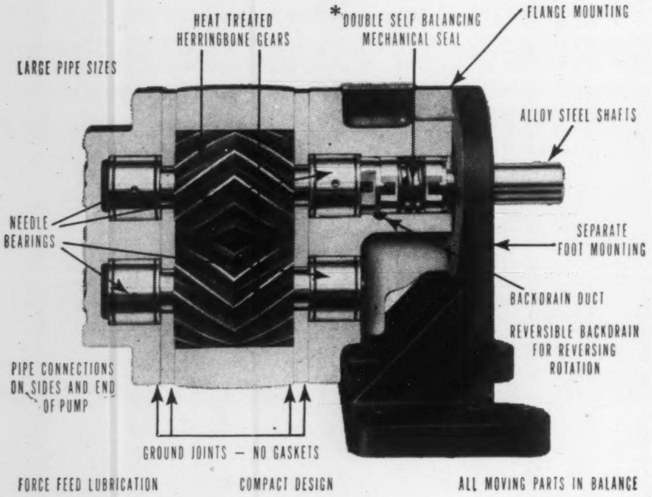
T.M. REG. U.S. PAT. OFF.

FIBERS • MATS • CLOTHS

***FIBERGLAS is the trade mark (Reg. U. S. Pat. Off.) of a variety of products made of or with glass fibers by Owens-Corning Fiberglas Corporation.**

14 Pointers

to BETTER PUMP PERFORMANCE IN HYDRAULIC SYSTEMS


LARGE PIPE SIZES
HEAT TREATED HERRINGBONE GEARS
*DOUBLE SELF BALANCING MECHANICAL SEAL
FLANGE MOUNTING
ALLOY STEEL SHAFTS
NEEDLE BEARINGS
SEPARATE FOOT MOUNTING
BACKDRAIN DUCT
REVERSIBLE BACKDRAIN FOR REVERSING ROTATION
PIPE CONNECTIONS ON SIDES AND END OF PUMP
GROUND JOINTS — NO GASKETS
FORCE FEED LUBRICATION
COMPACT DESIGN
ALL MOVING PARTS IN BALANCE

THE 14 FEATURES pointed out in this diagram present the real reasons for the superior performance of *Brown & Sharpe 500 Series Rotary Geared Pumps.* They are responsible for the quiet, efficient, dependable service which these pumps provide throughout years of operation, with a minimum of maintenance.

500 Series Rotary Geared Pumps are suited for service with pressures up to 500 lbs. per square inch. Operating speeds permit direct motor drives. Six sizes with capacities from 5.1 to 37.6 G.P.M. at 0 lbs. pressure. Get all the details. Write Brown & Sharpe Mfg. Co., Providence 1, Rhode Island, U.S.A.

**In all pumps of 500 Series except Nos. 507 and 511.*

BS

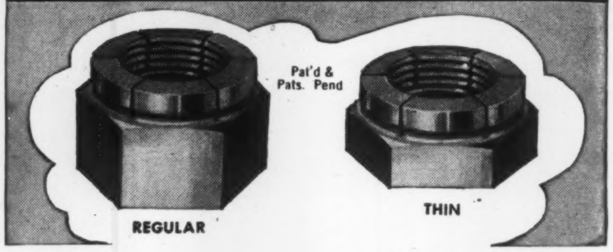
500 SERIES
ROTARY GEARED PUMPS

We urge buying through the Distributor.

GEARED • VANE • CENTRIFUGAL • MOTOR DRIVEN

BROWN & SHARPE PUMPS

FLEXLOC


Pat'd & Pats. Pend
REGULAR
THIN

SELF-LOCKING NUTS

Samples of our Flexloc Self-Locking Nuts will be sent free.

"Flexloc" packs maximum usefulness in minimum space because it is rugged, self-locking, compact—and is therefore becoming increasingly popular and this applies alike to U.S.S. and S.A.E. thread series.

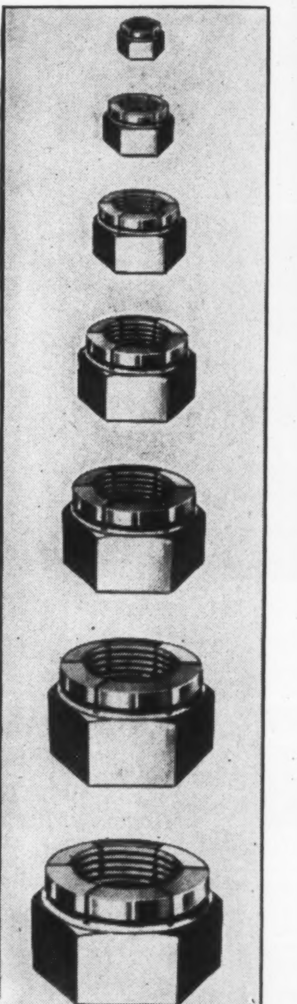
Every thread — including the locking threads—takes its share of the load.

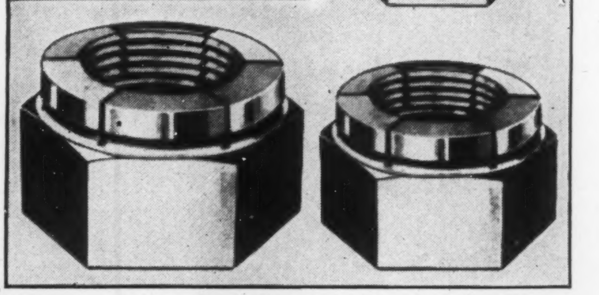
Covers a wide range of tolerances—from low No. 1 to high No. 3. Can be used over and over again without losing much of its locking ability.

Being a "stop" nut, it stays locked in any position on a threaded member. "Flexloc" Thin Nuts are especially popular, because their tensile is so high.

Sizes from No. 6 to 1" in diameter — **millions in use!**

Convince yourself with a few free samples.





OVER 44 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.
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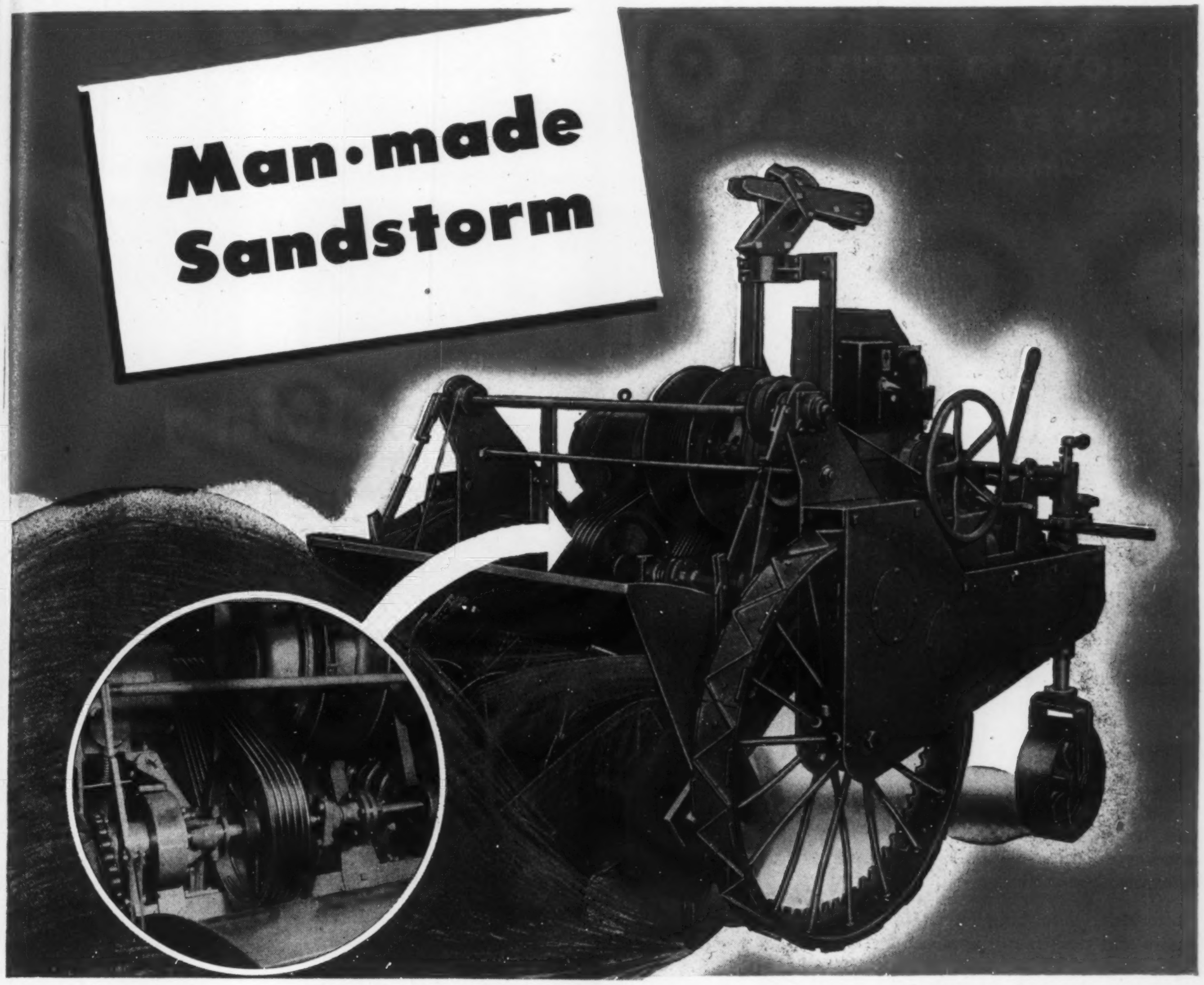
BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO



Dayton Multiple V-Belt Drive transmits power to sand conditioning blade

Drudgery of sand conditioning—the painfully slow method of shoveling—has been replaced by a modern, mechanized method. Now, a lawn mower type, cutting blade cylinder does the work easily, more uniformly. For fast, smooth and dependable power flow the designer specified a Dayton V-Belt Drive. And, as a result, uniform sand conditioning increases foundry production of better castings . . . at less cost per unit.

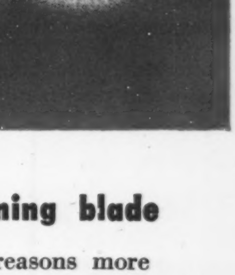
This is another of the many examples of the flexibility of Dayton V-Belt Drives. The capacity of Dayton V-Belt Drives to perform in excess of standard requirements—under all operating conditions—is another of the many reasons more industrial designers *consistently* specify *Daytons* for original equipment. A Dayton Power Transmission Specialist is ready to help you. Call or write: DAYTON RUBBER · DAYTON, OHIO.

NOW! **Rayon Cords*

PROVIDE DAYTON V-BELTS WITH

1. Minimum Stretch 2. Greater Flex Strength
3. Longer V-Belt Life

* Rayon cords are *specially processed* by Dayton for use in V-Belts to provide the most efficient and economical power transmission service for your machine needs. For the complete story write for booklet A-469.



Dayton Rubber

THE MARK OF TECHNICAL EXCELLENCE IN NATURAL AND SYNTHETIC RUBBER

THE WORLD'S LARGEST MANUFACTURER OF V-BELTS

HOW TO TIGHTEN A SOCKET SCREW'S GRIP

...without safety wires

Specify BRISTO "Multiple-Spline"

Defying vibration that often shakes "hex" screws loose . . . speeding assembly of products with hard-to-reach fastening points . . . easing disassembly — BRISTO "Multiple-Spline" Socket Screws are now making a hit with many designers and production men.

BRISTO "Multiple-Spline" gets its tighter grip from the unique way the wrench, geared to the spline-shaped socket, pulls the screw around. No expanding pressure. No bursting or rounding out of socket walls. Yet, a flick of the wrench releases the deep-seated grip.

Literature describing BRISTO "Multiple-Spline" Socket Screws and their many applications is yours for the asking.

THE BRISTOL COMPANY, Mill Supply Division, 122 Bristol Rd., Waterbury 91, Conn.

WHY "MULTIPLE-SPLINE" MEANS TIGHTER
NO EXPANDING PRESSURE: THE KEY PULLS THE SCREW AROUND

MULTIPLE SPLINE SOCKET
BRISTO SET & CAP SCREWS

Only the "B-LINE" has the right socket screw for every application

The BRISTOL Company
MILL SUPPLY DIVISION

"MULTIPLE-SPLINE" CAP SCREWS
"MULTIPLE-SPLINE" SET SCREWS
"HEX" CAP SCREWS
"HEX" SET SCREWS
"MULTIPLE-SPLINE" and "HEX" KEYS

At your service...

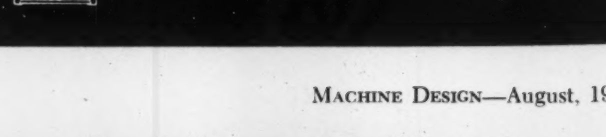
Specialists in Solving Speed-Control Problems

When you look to Lewellen you employ the pioneer* in speed-control

*Speed Control exclusively for more than 45 years

Wire, phone or write:
LEWELLEN MFG. CO.
Columbus, Indiana

LEWELLEN
Variable-Speed
TRANSMISSIONS—MOTOR PULLEYS



MACHINE DESIGN *Announces...*

THE 1947 DIRECTORY of MATERIALS

to be published as a part of the October issue

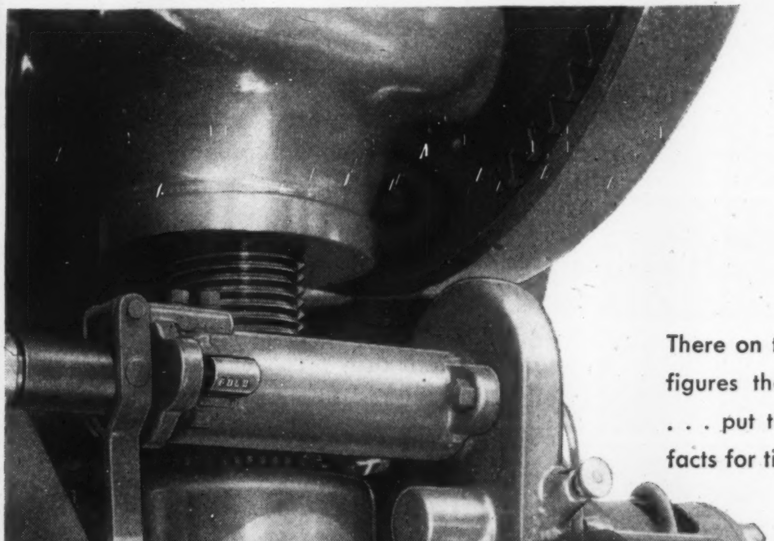
This fourteenth Directory of Materials is being completely revised and brought up to date by the MACHINE DESIGN editors to give you authoritative data on engineering materials. For your convenience, the Directory will be published in three sections which will contain:

1. **Detailed descriptions of properties, characteristics and typical applications of FERROUS AND NONFERROUS METALS and ALLOYS, PLASTICS and other NONMETALLICS—all conveniently arranged, alphabetically by tradenames.**
2. **An INDEX of MATERIALS arranged alphabetically by principal constituents which will enable you to select materials according to their chief properties, compare properties of similar materials and find tradenames.**
3. **An alphabetical listing of PRODUCERS of METALS, PLASTICS and other NONMETALLICS together with an explanation of the materials produced and their trade names.**

All of these data are to be arranged and compiled for your convenience so that whenever you need information on engineering materials it will be literally "at your pencil point".

The October issue of MACHINE DESIGN, containing this Directory of Materials will be a time-saving reference that you will want to keep on hand at all times. A limited number of extra copies of the Directory will be available from the Readers' Service Manager of MACHINE DESIGN, Penton Building, Cleveland 13, Ohio. They will be priced at $1.00 per copy.

Watch for MACHINE DESIGN *October Issue*



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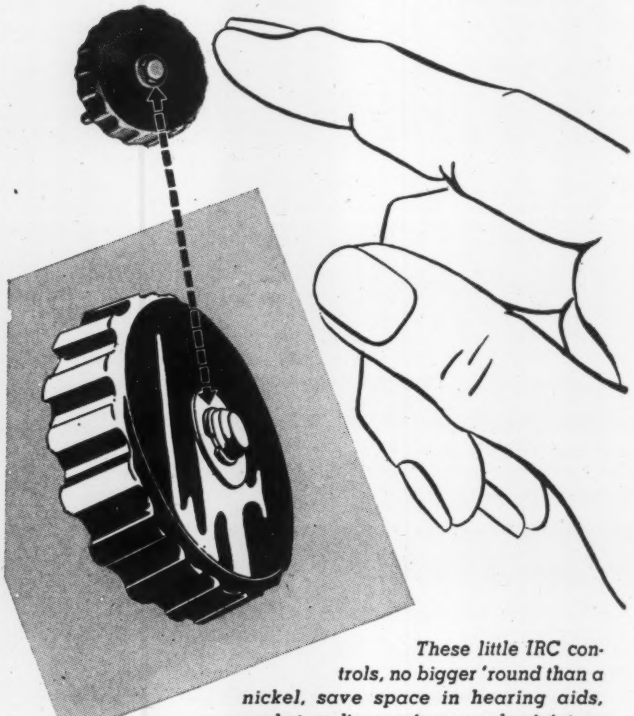

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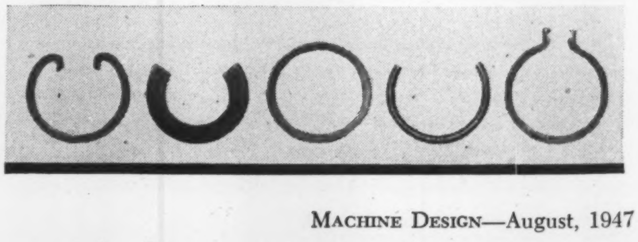

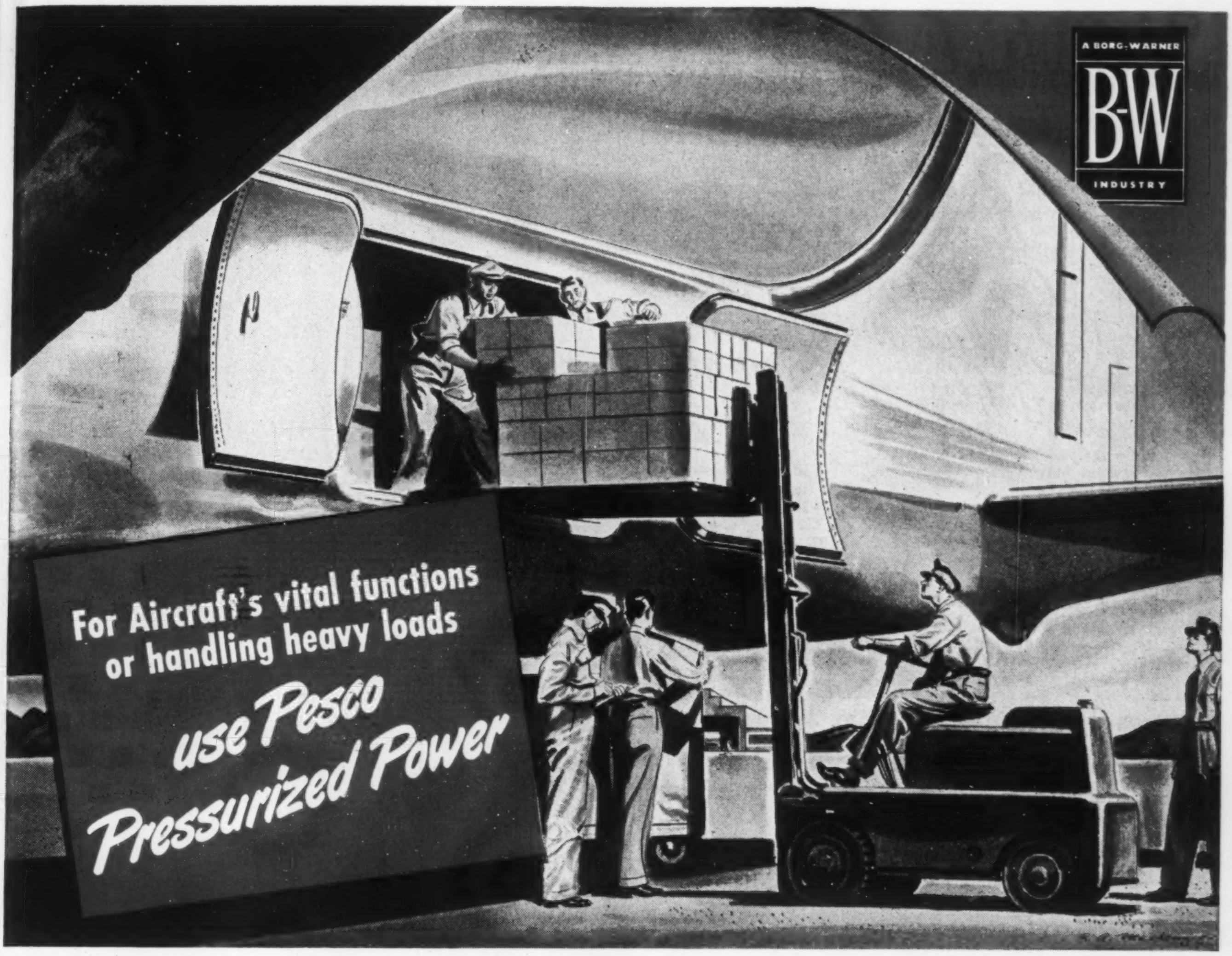

The pumps which supply gasoline to the engines, that feather the propellers, or operate the landing gear of a huge transport may seem far removed from the pump which raises and lowers the platform of the industrial truck used in loading and unloading it, but they aren't . . . for they both utilize *Pesco Pressurized Power.*

Hydraulic power, as developed at *Pesco*, can be used for operating and controlling the most delicate machinery, or for applying tremendous power and pressure wherever needed. At *Pesco*, the same skills and precise accuracy required to develop and build small, lightweight hydraulic pumps and electric motors that operate all-important flight instruments and other vital aircraft equipment, are employed to design and build industrial hydraulic pumps and control valves that provide finger-tip operation in handling the heavy blades of bulldozers . . . lifting and lowering farm tractor implements . . . operating dump truck bodies . . . and many other "on-the-ground" jobs.

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

60. Foot Switches

Euclid Electric & Mfg. Co.—8-page illustrated bulletin No. 1021 presents information on foot operated master switches for use on rubber machinery, spot welders and other industrial equipment.

61. Water Coolers

Ross Heater & Mfg. Co.—6-page illustrated bulletin No. 5222 covers marine applications of type BCP lube oil and jacket water coolers. Features of design are listed. Cross-section and dimensional drawings detail advantages and construction.

62. Flexible Coupling

Irving Flexible Coupling Co.—8-page illustrated bulletin describes Irving flexible coupling. Eighteen features of design and construction are outlined. Exploded view of unit shows simplicity. Dimensional data and horsepower ratings are covered in tabular form.

63. Glossary of Plastic Terms

B. F. Goodrich Chemical Co.—12-page glossary of chemical names, terms and phrases used in plastic and rubber industries is compiled for use by engineers and production men in plants where plastics and plastic products are designed, fabricated and manufactured.

64. Adhesives

Pennsylvania Coal Products Dept., Koppers Co.—8-page instruction booklet describes Penacolite G-1215 room temperature setting adhesive, outlines application procedure and covers properties and data on bonding to various types of materials.

65. Hole Punching Units

Wales-Strippit Corp.—8-page illustrated bulletin CJ describes type CP hole punching units that punch material up to ¼-inch thick. Unit has pedestal die that permits punching holes in angles and channels as well as in sheet material.

66. Self-Lubricating Bearings

Wel-Met Co.—4-page illustrated bulletin form No. 100 describes advantages and features of Wel-Met self-lubricating bearings, bars and plates. Specifications are given and table shows size range. Powdered metal parts also are covered briefly.

67. Liquid Level Gages

Swift Lubricator Co.—Eight full-scale line prints of liquid level gages and gage cocks are intended for use by designers for incorporation in scale drawings utilizing this equipment. Exact specifications for various sizes are included. Cross-sections show details of construction of these gages and accessories.

68. Bushing Stock

Shenango-Penn Mold Co.—4-page illustrated bulletin No. 145 covers centrifugally cast bushing stock, lists all sizes, gives inside and outside diameters and approximate weights. Inherent differences between bushing stock produced by usual casting methods and this centrifugally cast method are explained.

69. Signal & Control Equipment

Autocall Co.—8-page illustrated brochure covers line of electrical signal and control equipment for public utility and industrial power plants. Featured is section on relays and switches including transformer pressure-temperature device which automatically warns of excess pressure and/or temperature in oil filled transformers, voltage regulators, etc.

70. Electric Motors

Westinghouse Electric Corp.—4-page illustrated bulletin No. 3100-3-CSP presents data and information on line of type CSP Life-Line totally enclosed, fan cooled, constant speed squirrel-cage motors. Motors with horsepower ratings from 1 to 20 are available for 208, 220, 440 and 550 volts, 60, 50 and 25 cycles and in NEMA frame sizes 224 through 326.

71. Insulated Electrodes

Stupakoff Ceramic & Mfg. Co.—16-page illustrated bulletin No. 447 presents specifications, stock and special sizes and styles and includes specific electrical characteristics on line of Kovar-Glass insulated electrodes for soft soldering to electronic devices where permanent vacuum or pressure tight seal is required.

72. Synthetic Rubber Insulations

Simplex Wire & Cable Co.—12-page illustrated brochure entitled "Our Third Report to Industry on Simplex Synthetic Rubber Insulations" is discussion of synthetic versus natural rubber materials for electrical insulating purposes. Data and information in support of company's preference for synthetic materials is presented.

73. Vibration Isolators

Lord Mfg. Co.—Illustrated bulletin No. 106 describes Multiplane mounting which is designed to provide isolation from vibration regardless of direction of disturbing forces. Lightweight unit is applicable to instruments, electronic equipment and other devices of high sensitivity as well as engine-generator sets, air conditioning equipment, pumps, blowers, etc.

74. Tracing Cloth

Arkwright Finishing Co.—12-page booklet contains 8½ x 3½ inch samples and specifications of four types of tracing cloth for ink or pencil drawings.

75. Lock Nut

Nylock Corp.—4-page illustrated bulletin lists nine advantages of Nylock Nylon self-locking nuts. Nylon locking insert, which replaces fiber material formerly used in company's product, features high reusability and low absorption qualities.

76. Asbestos Textiles

Asbestos Textile Institute—32-page illustrated booklet "A Primer on Asbestos Textiles" describes these textiles and offers ideas to designers, engineers and production men on their use in production of various items. Characteristics of material and broad range of applications are given.

77. Lubricating Systems

Farval Corp.—8-page illustrated booklet entitled "Studies in Centralized Lubrication" presents case histories demonstrating economies and improved efficiency following installation of Farval centralized lubricating systems.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

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78. Industrial Filter Equipment

Titeflex, Inc.—4-page illustrated folder No. 120 describes Titeflex filter which combines simplicity of operation with ease of cleaning. All-stainless steel laboratory filter and all-metal flexible tubing are also covered.

79. Heating Coils

H. W. Tuttle & Co.—14-page illustrated loose-leaf catalog "Heating Coils for Electrical Service and Repair" is compilation of data sheets which cover wide range of coils for such appliances as flat irons, toasters, water heaters, room heaters, hot plates, etc.

80. Air Valves

Valvair Corp.—24-page illustrated booklet deals with two, three and four-way hand lever, foot, cam, diaphragm or solenoid operated air valves. They can be assembled in normally open or normally closed positions in relation to control. Valves are made in ¼, ⅜, ½, ¾ and 1-inch sizes.

81. Hydraulic Control Equipment

Hydraulic Hi-Speed Co.—26-page illustrated catalog No. 2-47 lists and describes pressure, volume and directional control equipment for use in wide range of hydraulic systems. Equipment can be manually, cam, lever or solenoid operated depending upon application and working specifications.

82. High Pressure Pumps

John Bean Mfg. Co.—8-page illustrated catalog No. L-623 describes line of high pressure, plunger cup packing type industrial pumps capable of delivering volumes from 2 to 80 gallons per minute with pressures up to 800 pounds per square inch. Design and construction features are outlined.

83. Gears

Amgears, Inc.—6-page folder "a check list for the Gear Buyer" outlines company's manufacturing facilities for producing spurs, worms and worm gears; racks, spiral or spiral miter and bevel gears. Engineering, manufacturing and inspection controls are covered.

84. Transformers

Chicago Transformer Div., Essex Wire Corp. —8-page illustrated catalog No. CP-447 deals with control and power circuit transformers intended for operation on 115-volt power supply to supply low voltages to industrial appliances. Electrical specifications, dimensions and weights are listed.

85. Rotary Pumps

Blackmer Pump Co.—6-page illustrated folder No. 306 deals with line of single, twin and multiple pump units which are V-belt, steam turbine or directly connected. Hand pumps and marine pumps also are discussed and swinging vane principle of operation is explained.

86. Clutches & Hydraulic Drives

Twin Disc Clutch Co.—52-page illustrated brochure "Production Road" deals with problems of power transmission and how they can be overcome. Clutch or hydraulic drive for practically every application in industry is illustrated.

87. Machinable Ceramic Material

American Lava Corp.—4-page folder No. 147 presents information on AlSiMag 222 machinable ceramic which is porous material having mechanical strength of fired lava and approaches physical strength of commercial dry press porcelain. Material can be turned on lathe like steel.

88. Portable Testing Machines

Greer Hydraulics, Inc.—4-page illustrated folder "Portable Hydraulic Test Machines" presents general and detailed specifications and operating diagrams of five different testing machines for aircraft maintenance and service, and nine stationary models.

89. Lubricant Research

Gulf Oil Corp.—24-page illustrated brochure entitled "Better Lubricants for Industry Through Research" is pictorial story of lubricant development ranging from modern techniques of oil discovery through refining, analysis, testing and creation of future products.

90. Felt Data

American Felt Co.—Data sheet No. 13 discusses reaction of standard specification felts to various loads. Tables show load deformation properties and compression set characteristics of SAE felts. Tips are given on selecting proper material for any given application.

91. Oil Filters

Briggs Filtration Co.—4-page illustrated folder No. SM-293-46 deals with Discel A-414 Discbloc A-445 and Bloc A-447 standard refills for oil filters which are all interchangeable and can be used for straight mineral oils or heavy duty petroleum oils. Installation information is included.

92. Magnetic Starters

Arrow-Hart & Hegeman Elec. Co.—4-page illustrated folder "New Magnetic Starter Right Angle" describes size No. 2 starters which have right-angle balanced mechanism to multiply 15-pound magnet pull to 25 pounds at contacts. Control requires but 8.5 watts closed and 75 watts inrush. Hookup, wiring, contacts and arc control data are included.

93. Castings

Universal Castings Corp.—16-page illustrated bulletin No. 4000 describes manufacturing facilities for producing precision nonferrous parts. Design, patterns, production control and results are discussed. Castings made of brass alloy, aluminum, bronze, manganese bronze, silicon bronze, nickel-aluminum bronze, beryllium-copper, etc. are shown.

94. Electrical Controls

Potter & Brumfield Sales Co.—20-page illustrated catalog No. 246 provides technical information about heavy duty, medium duty, light, shock, multiple-leaf, plate circuit, voltage controlled and special relays. Relay specification sheet is included and covers all items of information necessary for choosing proper type unit for any given application.

95. Gasoline Engines

Clinton Sales Co.—6-page illustrated folder "Power To Spare" reveals specifications, general operating data and features of model No. 700 Clinton all purpose 4-cycle, air cooled gasoline engines for adaptation to tractors, scooters, power plants and spray equipment in addition to belt conveyors, grain elevators, compressors, pumps, lawn mowers, etc.

96. Hydraulic Clamp Unit

John S. Barnes Corp.—Illustrated data sheet No. 305-U describes Rapidraulic Junior hydraulic clamp unit which is small, compact and designed for rapid operation and high holding pressure of 500 pounds per square inch. Unit is recommended for actuating lathe chucks, to clamp cylinders for fixtures and many other applications.

97. Portable & Fixed Tachometers

Jones Motrola Corp.—10-page illustrated catalog No. 146 deals with continuous indicating portable and fixed types of tachometers for diverse applications. Instruments can indicate on any dial in any terminology by converting revolutions per minute into terms desired. Various sizes have dials ranging from 3 to 10 inches in diameter.

98. Stainless Steel Tubing

Babcock & Wilcox Tube Co.—4-page illustrated folder "B & W Stainless Steel Tubing" lists applications of stainless Croloys of the 18-8 group for food processing industries in applications such as process piping, evaporating and condensing equipment, heat exchangers, precoolers, pasteurizing and sterilizing equipment and other related uses.

99. Miniature Ball Bearings

Miniature Precision Bearings, Inc.—4-page bulletin describes five series of precision ball bearings for precision instruments and mechanisms. They are radial, super-light radial, pivot, angular contact and thrust types. Load ratings, recommended for average typical requirements are given. Engineering service and facilities for design and production of special ball bearings are covered also.

100. Rotary Shaft Seals

Rotary Seal Co.—12-page illustrated catalog No. 547 deals with various rotary shaft seals which rotate with shaft. Running seal joint is formed by contact between surface of seal face mating with stationary seal seat. Seals are suited for a variety of applications and can be fabricated to fit specific requirements.

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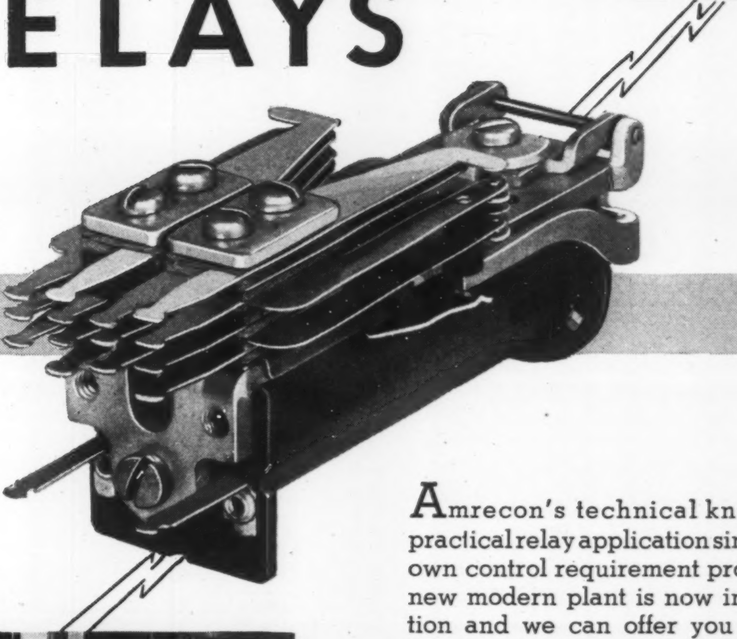

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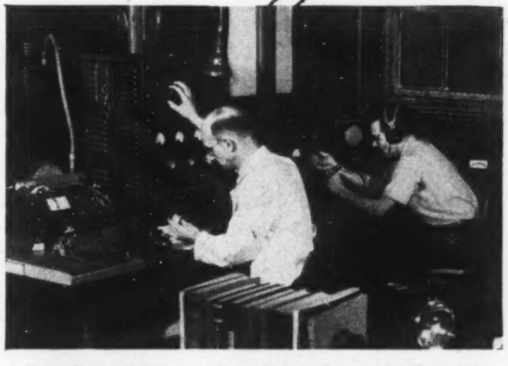

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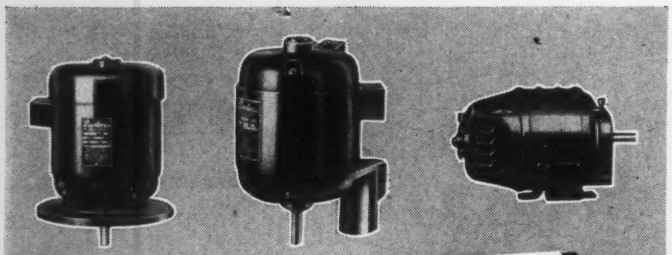

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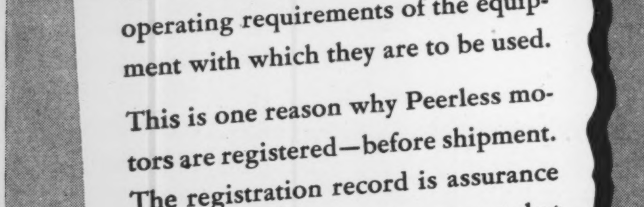

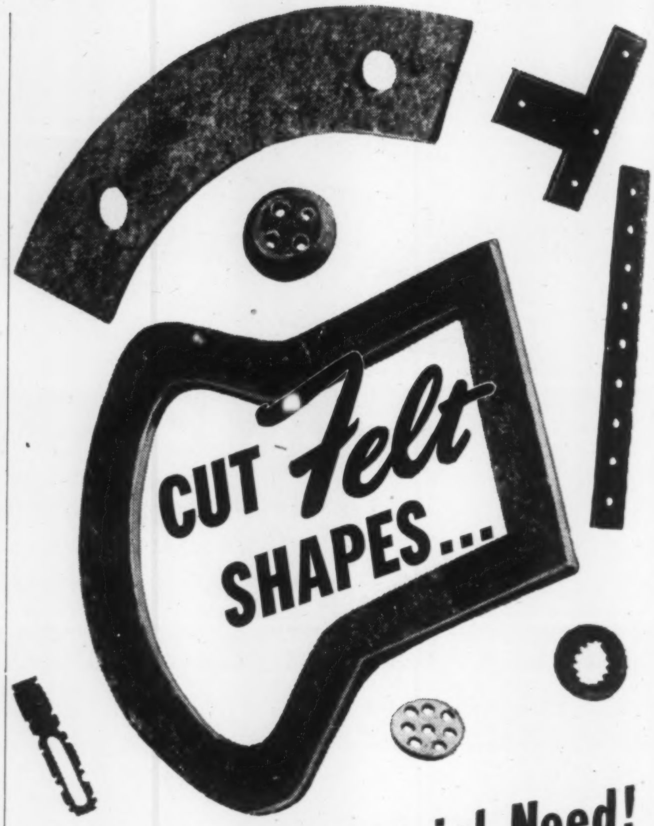

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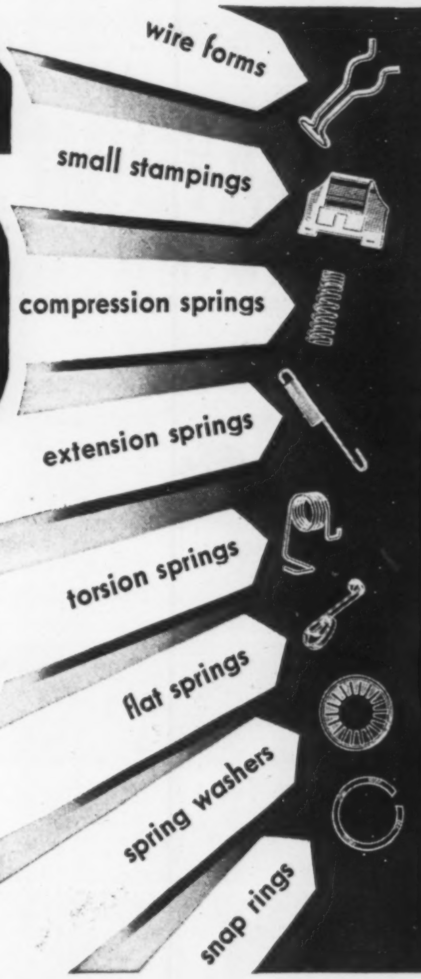

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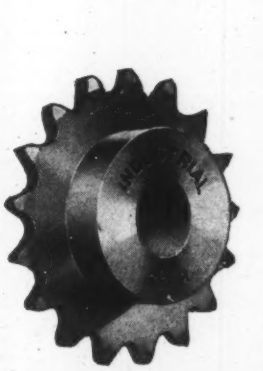

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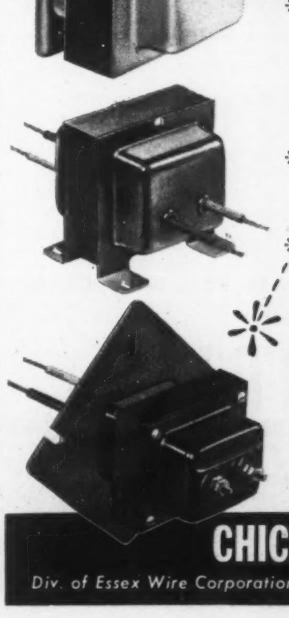

*For step down from 115 volts. Normal reactance types with 8, 16, 24, and 32-volt secondaries, capacities from 25 to 150 va. High reactance types with 25 and 30-volt secondaries, capacities from 20 to 80 va.

*For step down from 230, 460, or 575 volts, 50 or 60 cycles. With 115 or 115/230-volt secondaries, capacities from 25 va to 10 KVA.

*Compact, convenient mountings to fit a wide variety of applications.

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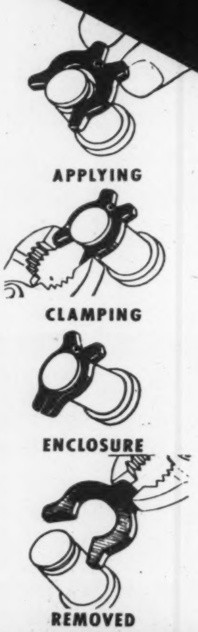

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There is a wide variety of EWC wheels and axles for every type of mobile equipment . . . one or several may be ideally suited to your product. For unusual wheel problems, we offer you a complete engineering service, with a thoroughly experienced staff and unexcelled facilities. Write today for complete information.

ELECTRIC WHEEL CO., Quincy, Illinois, Est. 1890

KUX

EXPERTS AT

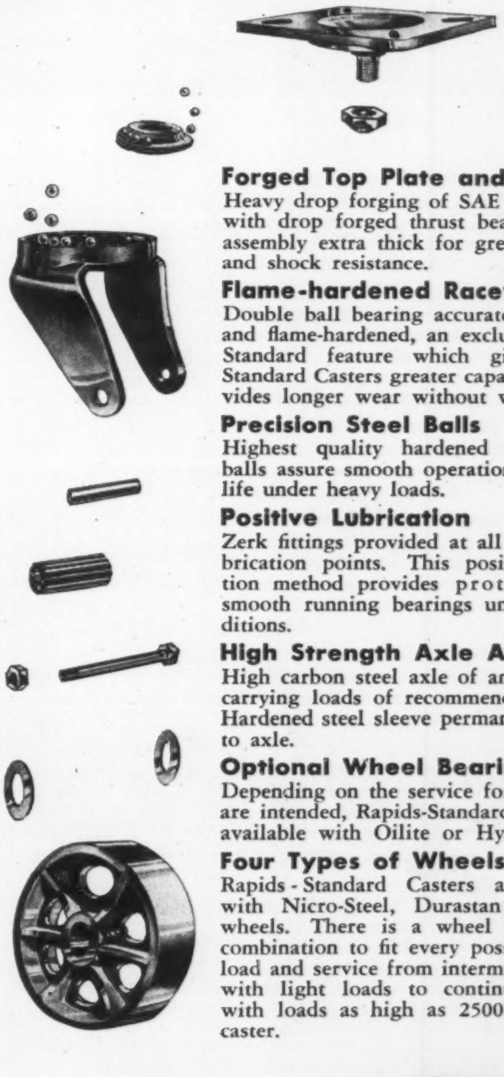
CAM

CUTTING and GRINDING

The largest, most completely equipped plant in the country devoted to CAM cutting and grinding is at your service. 25 YEARS of experience in making special cams for thousands of companies has made us experts at cam cutting and grinding. Our facilities and equipment, finest in the country, permit us to manufacture any style or size Cam, Geneva Motion or Scroll Plate in quantities of 1, 10 or 10,000. Accuracy can be maintained to split thousandths, and surfaces to micro-finishes. Send us specifications or blueprints and we will be glad to submit a detailed quotation on your requirements.

KUX MACHINE COMPANY
3928 WEST HARRISON STREET • CHICAGO 24, ILLINOIS

This is why RAPIDS-STANDARD CASTERS *are Better*



Forged Top Plate and Yoke
Heavy drop forging of SAE steel. Fitted with drop forged thrust bearing. Entire assembly extra thick for greater capacity and shock resistance.

Flame-hardened Raceways
Double ball bearing accurately machined and flame-hardened, an exclusive Rapids-Standard feature which gives Rapids-Standard Casters greater capacity and provides longer wear without wobble.

Precision Steel Balls
Highest quality hardened and ground balls assure smooth operation and longer life under heavy loads.

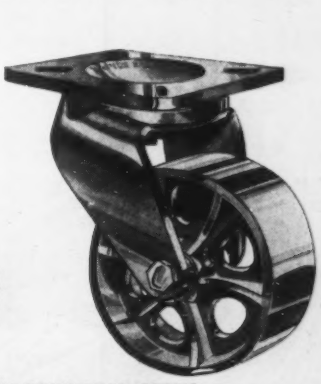
Positive Lubrication
Zerk fittings provided at all essential lubrication points. This positive lubrication method provides protection for smooth running bearings under all conditions.

High Strength Axle Assembly
High carbon steel axle of ample size for carrying loads of recommended capacity. Hardened steel sleeve permanently locked to axle.

Optional Wheel Bearings
Depending on the service for which they are intended, Rapids-Standard Casters are available with Oilite or Hyatt bearings.

Four Types of Wheels
Rapids-Standard Casters are available with Nicro-Steel, Durastan or Rubber wheels. There is a wheel and bearing combination to fit every possible type of load and service from intermittent service with light loads to continuous service with loads as high as 2500 pounds per caster.

This new catalog lists the complete Rapids-Standard Caster line together with specification, capacities and suggestions for more efficient use. Write for your copy today.



OFFICES IN PRINCIPAL CITIES
Manufacturers of
STEEL FORGED CASTERS • TRUCKS • CONVEYORS • POWER BOOSTERS

The Rapids-Standard Co., Inc.

Sales Div.—330 Peoples Nat'l Bank Bldg., Grand Rapids 2, Mich.

When..... DESIGNING Precision PRODUCTS

Specify... BL GROUND SHAFTING

Wherever the detail drawings of a new machine call for "B&L Cold Finished GROUND SHAFTING" . . the engineer can be sure that he has all the factors required for accurate design and dependable service.

This finely made material is produced to highest standards of uniformity, straightness, concentricity, smooth surface and close size tolerances. It is considered the "Aristocrat of Ground Rounds" for exposed applications, where a bright, smooth, flawless finish is important.

Available in a wide range of sizes and grades:—DRAWN, GROUND AND POLISHED, or TURNED, GROUND AND POLISHED . . . to standard or special accuracy.

COLD FINISHED BAR STEELS AND SHAFTING

WRITE FOR THE B&L PRICE-A-LATOR

A handy slide calculator for figuring the price extras on Cold Finished Bar Steels.

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Sales Offices in all Principal Cities

FLEXIBLE SHAFTS

Flexible Shafts that carry power around any corner have many new uses in peace-time developments. Faithful, dependable power drives or remote control in airplanes, automobiles, radio, and many other commercial products. Shafts made to your specifications. Our engineering department will work out your particular power problem without obligation.

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WEST COAST BRANCH: 431 Venice Blvd.; Los Angeles 15, Cal.

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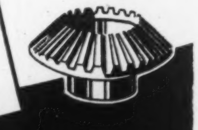
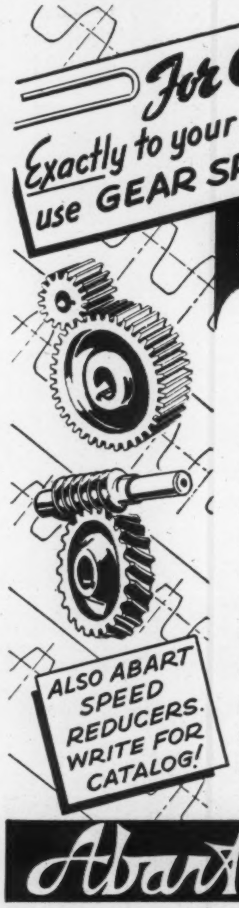
Exactly to your specifications use GEAR SPECIALISTS!



Abart


ALSO ABART SPEED REDUCERS. WRITE FOR CATALOG!

Abart's long gear engineering experience, with most modern equipment, is concentrated on gears to each customer's individual requirements. Abart Gears therefore are not just another standard item. This accounts for the Abart superiorities in gear performance, long life and economy.

Bring your gear problems to Abart: Spur, Bevel, Worm, Worm Wheels, Helical and Spiral, Internal, Sprockets and Machine Racks. Any quantity, small or large. Send sample, B/P or specifications for prompt estimate.

Abart GEAR & MACHINE CO.

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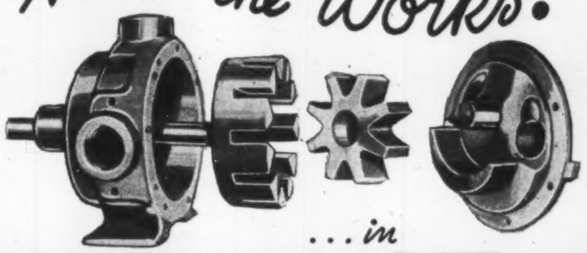

. . . in

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Simple to the nth degree. Just 2 moving gears—one within the other. Both self supported. Positive in action. Smooth, even flow with no pulsation. Handles any clean liquid regardless of viscosity. Low speed. Full, fast delivery. Long life. Complete line of models and sizes with pressures ranging from 5 to 500 psi. depending on style of pump.

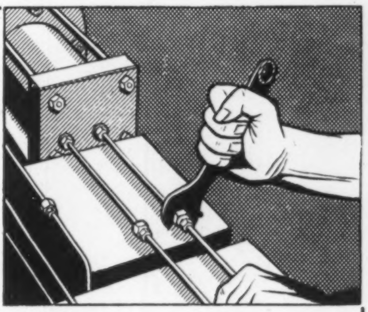
If it is your job to see that liquids are moved, see Viking for the answer. Write today for the folder that will help you 47SH.

VIKING PUMPS FIRST IN AMERICA

See Our Catalog In SWEETS

VIKING *Pump* COMPANY
CEDAR FALLS, IOWA

FLODAR *Griptube* FITTINGS



CAN BE REUSED REPEATEDLY

Flodar's unique sleeves of especially heat treated, tough alloy spring steel will not jamb within the nut permitting repeated use of the fittings.

Grip Tube Fittings provide trouble free permanency of installation—become part of the tube. Their spring steel sleeves increase tensile strength resiliently support the tube against vibration—protect the flare and provide self alignment of tubes saving installation time and maintenance costs.

Available in Straight, Union, Elbow, Side-Tee, Tube-Tee and Cross, both male and female. Sizes from ¼" to 1½".

Specialists in Large Size Fittings

Write for Illustrated Folder and Complete Specifications

FLODAR CORPORATION
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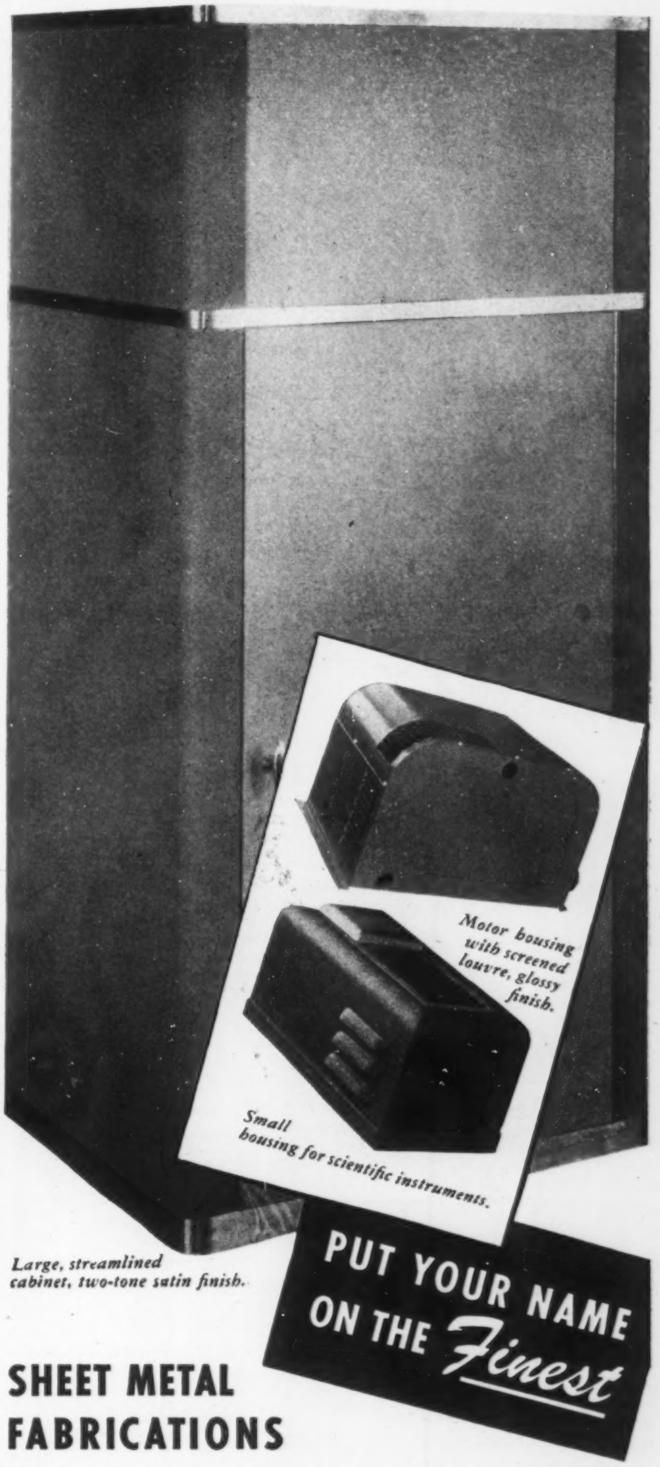

Motor housing with screened louvre, glossy finish.

Small housing for scientific instruments.

Large, streamlined cabinet, two-tone satin finish.

PUT YOUR NAME ON THE *Finest*

SHEET METAL FABRICATIONS

● Anything *less* than the finest is a damaging reflection on the quality of your product—a loss of prestige, profits. Actually, it costs you no more to invest in R & T superior craftsmanship, because labor and material costs are usually unaffected. The *difference* is in the *results*—better fabrications—more prestige and profits for you.

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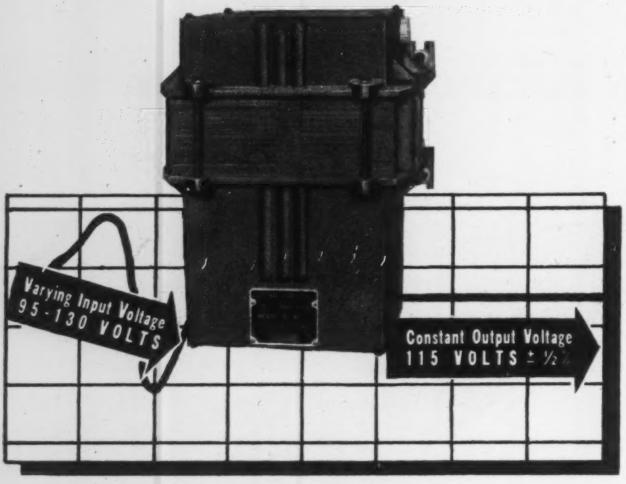
VPS* Trouble?

For a POSITIVE Cure use...

RAYTHEON Voltage Stabilizers

*Varying **P**ower **S**upply need *not* prevent efficient, reliable and accurate performance of electrically operated equipment. A Raytheon Voltage Stabilizer of correct characteristics and capacity built into new equipment, or installed on old, provides constant output from varying input. Assure reliable and accurate performance of *your* equipment through *positive control* of power supply. Ask about Raytheon Voltage Stabilizers to meet *your* requirements.

Write for illustrated Bulletin DL-47-537



- **OUTPUT VOLTAGE CONTROLLED** to within ± ½%.
- **STABILIZATION AT ANY LOAD** within rated capacities.
- **QUICK RESPONSE**... varying input voltage stabilized within 1/20 second.
- **ENTIRELY AUTOMATIC**... no adjustments, no moving parts, no maintenance.

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Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
COMMERCIAL PRODUCTS DIVISION
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Industrial and Commercial Electronic Equipment, Broadcast Equipment, Tubes and Accessories
Sales Offices: Atlanta, Boston, Chicago, Cleveland, Louisville, New York

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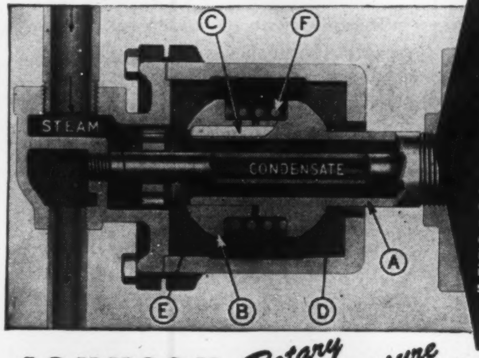
Help FOR YOUR STUFFING BOX PROBLEMS . . .

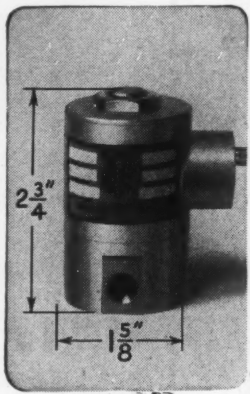
Getting steam or liquids into rotating machine parts used to mean a lot of trouble with stuffing boxes and steam fits. The Johnson Joint has changed all that. It's completely packless, self-oiling, self-adjusting and even self-aligning. Industry is finding new uses for it every day. Type B illustrated provides for condensate removal; other styles and sizes for all needs. Write for details.

THE JOHNSON CORPORATION
811 WOOD ST., THREE RIVERS, MICH.



Nipple (A) connected to roll. Collar (B) is keyed (C) to nipple, but fits loosely so pressure can fill housing and force seal ring (D) in place. Both rings (D and E) are of carbon graphite, eliminate oiling and packing. Spring (F) is for initial seating only.

JOHNSON *Rotary Pressure* JOINTS



Stainless Steel

THREE WAY - TWO POSITION
TWO WAY - NORMALLY CLOSED
TWO WAY - NORMALLY OPEN

Solenoid Valves

IDEAL GAS AND FLUID CONTROL

STANDARD
5 TO 250
P. S. I.

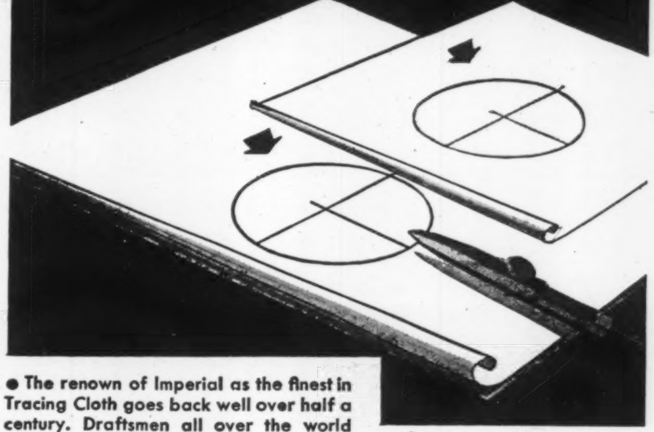
SPECIAL
5 TO 850
P. S. I.

HUNDREDS OF MODELS — SPECIAL APPLICATIONS

Stainless steel Allied Solenoid Valves are highly resistant to corrosion and oxidation—the coils are impregnated to withstand moisture—spring loading insures positive closing—soft insert, against a stainless seat, prevents leakage. Allied valves weigh only one pound, are 2¾" high and 1⅝" in diameter, yet operate easily and dependably at maximum operating pressures, controlling any media such as water, alcohol, oil, air, gas, etc. Standard valves are rated 10 watts maximum A.C. or D.C. Many models are approved by both Underwriters' Laboratories and Factory Mutual. Write for catalog for full engineering details.

ALLIED CONTROL VALVE DIV.
The Skinner Chuck Co.
133 BELDEN AVENUE, NORWALK, CONN.

TRACING CLOTH THAT DEFIES TIME



● The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

IMPERIAL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

Design Engineers Specify

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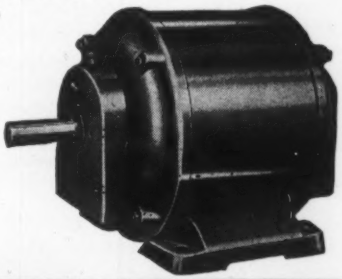
Ball Bearing

MOTORS

Because-

- They offer more flexibility in power planning.
- They are built to meet unusual power loads and high temperatures.
- They meet all operating conditions where hazards of liquids, chips, etc., dropping into the motor are involved; as well as splash conditions.
- Being made in ½ to 75 h. p. sizes, they offer wide adaptability.



VALLEY
ELECTRIC CORPORATION
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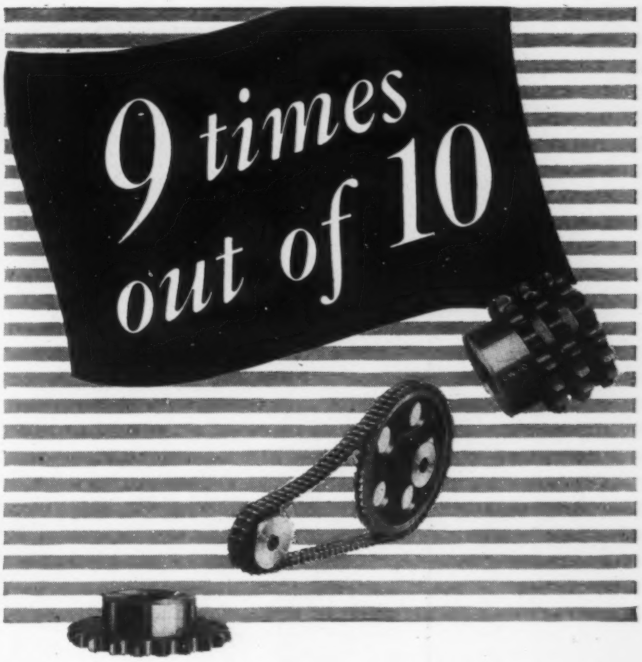

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Stock Design **SPROCKETS**

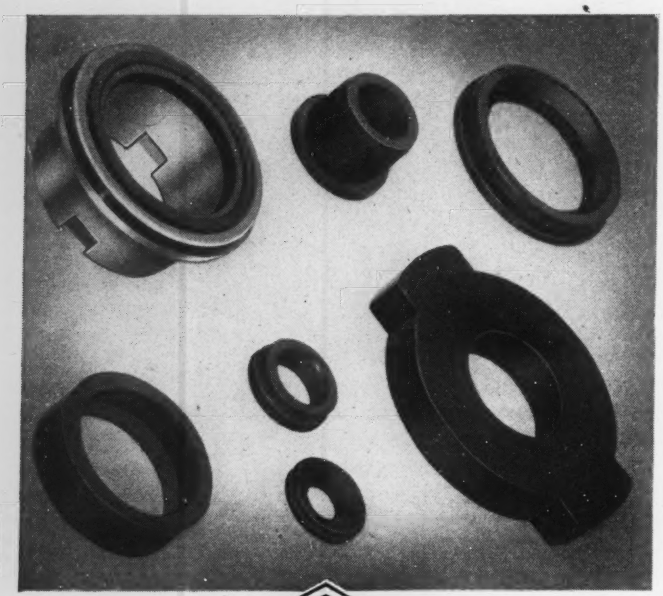
will do the job—Better!

With 2,000 types to select from—you are almost certain to find just the size you need for practically every transmission requirement—ready for immediate delivery. Cullman Sprockets—produced by fast, low-cost, high-precision methods—asssure top operating efficiency. "Specials," too, *are quickly available*—made up by exclusive Cullman methods and specialized equipment.

CULLMAN
SPROCKETS

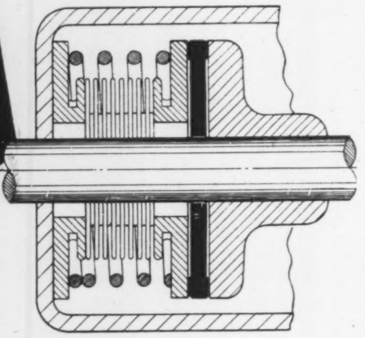
Write today for free catalog containing useful data and helpful facts for sprocket users. It lists dimensions.

CULLMAN WHEEL COMPANY
1336 Altgeld Street Chicago 14, Illinois



PURE

CARBON SEAL RINGS
CAN LICK *Your*



Sealing Problems

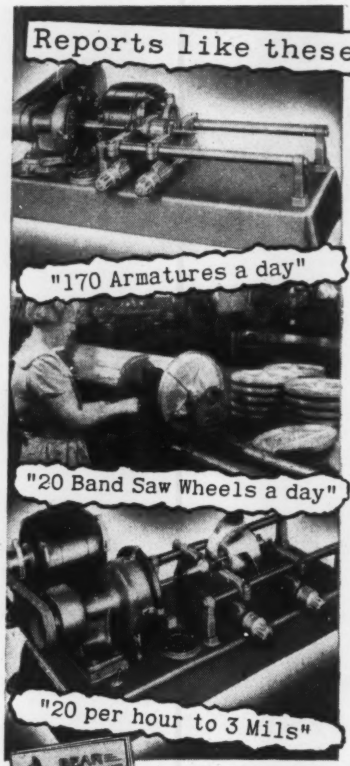
Pure Carbon Seal Rings are vital to solving sealing problems. Wherever two surfaces lap together lubrication is difficult and often impossible. Under these conditions the self-lubricating, non-seizing characteristics of carbon is extremely useful.

Chemically inert with a low coefficient of expansion, these rings are highly resistant to oxidation and corrosion. Pure Carbon materials are supplied in more than 20 different grades. Each grade is made from specially developed carbon to meet one or more of the varying requirements of temperature, speed, porosity and character of material to be sealed.

Our Bulletin No. 461 describes these grades in detail, giving specific recommendations for all types of service. Write for it today.

PURE CARBON CO., INC.

446 HALL AVENUE, ST. MARYS, PA.



prove how Bear Dy-Namic Balancing can help you!

The experience of leading manufacturers has shown how Bear Dy-Namic and Static Balancing can cut time and labor costs and give accurate, dependable results . . . at production line speed. Any shop hand can learn Bear Balancing in half a day. Bear Balanced Rotating Parts increase the life and efficiency of any machine . . . and add real sales appeal to the finished product.

*Reports from actual Bear Equipment Users will be sent on request.

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BEAR MFG. CO., Dept. M-4, Rock Island, Illinois

BEAR
COMBINATION 2337
STATIC AND DY-NAMIC BALANCING MACHINES

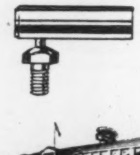
TOUREK
BALL JOINTS

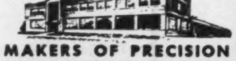
...the recognized standard!

Manufacturers all over the world are specifying Tourek Ball Joints wherever this type of product is needed because they know that the Tourek line of stock types and sizes will meet the most exacting requirements. When special types are necessary, they call upon Tourek's engineering and production know-how to give expert assistance.

Tourek is ready to help meet your particular needs, whether ball joints or precision screw machine products —write today for complete data.

J. J. TOUREK MFG. CO.
4701 W. 16th Street, Chicago 50, Illinois

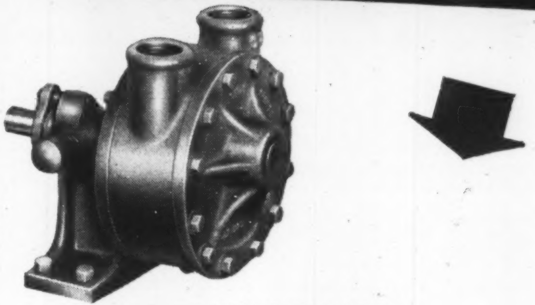




MAKERS OF PRECISION
SCREW MACHINE PRODUCTS

ESTABLISHED 1920
TOUREK
FAMOUS BALL JOINTS

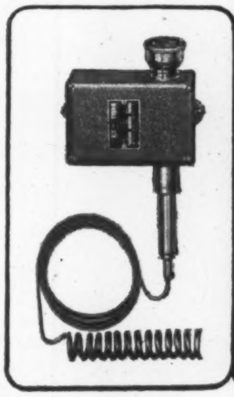
PERFORMANCE FEATURES OF TUTHILL Coolant Pumps



- ★ POSITIVE DELIVERY
- ★ SELF-PRIMING
- ★ BUILT-IN AUTOMATIC BY-PASS
- ★ CAPACITIES UP TO 50 G.P.M.
- ★ AVAILABLE IN STRIPPED MODELS

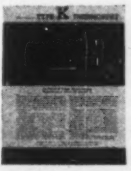
Write for Tuthill Model M bulletin

TUTHILL PUMP COMPANY
939 East 95th Street • Chicago 19, Illinois



THE TYPE K THERMOSTAT IS EASILY ADAPTED FOR MANY *Special* APPLICATIONS

The Type K Thermostat is available in five models with calibrated micrometer adjustments, covering three temperature ranges, —120° to —180° F., —50° to 350° F. and 50° to —600° F. Great accuracy of setting in any part of the wide adjustable temperature ranges is obtained by means of a calibrating screw. The Type K is available with stainless steel or mild steel assemblies for use on special applications in liquids or gasses which are injurious to standard copper thermal assemblies. Special models with explosion-proof housings are available. The Type K Thermostat carries the approval of the Underwriters Laboratories, Inc. Send for bulletin 441-T containing full details.



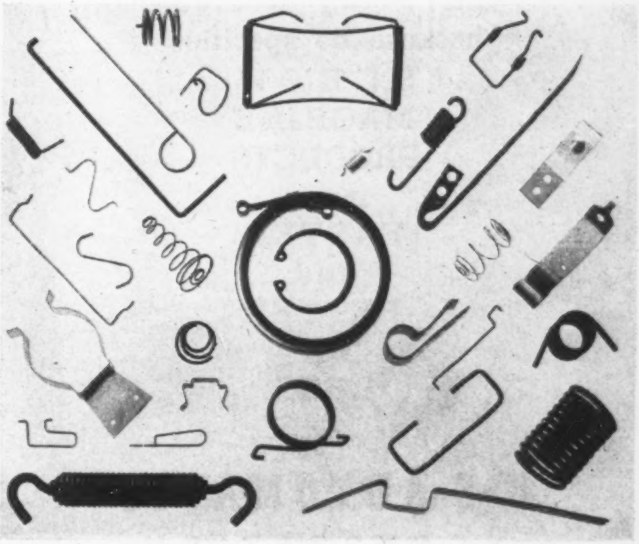
United Electric Controls Company
DEPT. B, 69-71 A STREET, BOSTON 27, MASS.

Why Worry about your SPRINGS? *See* RELIABLE

Are you worried about spring quality? We have pleased so many exacting customers—we certainly can please you too. Are you worried about spring design? Get your springs from spring experts—but be sure they *are* experts. Are you worried about spring costs? They should be carefully controlled, but—what does a spring cost if it *fails?* The *lowest priced* spring may be an ever-present threat to the efficiency of your product.

If you want higher quality on any type of springs, wire forms, or spring stampings, try Reliable. We *mean* it when we say our aim will be to give you better springs and better service, at the lowest cost consistent with the quality standards of your own product.

When sending inquiry, describe springs as completely as possible, sending sketch, samples, or blue print. Mention any special requirements known, such as working space, initial tension, and load. Our engineers are ready to work with you. Catalog on request. Ask for Bulletin: "Buying the Right Springs Right."



THE RELIABLE SPRING & WIRE FORMS CO.
3167 Fulton Road **Cleveland 9, Ohio**
Representatives in Principal Cities

YOU CAN RELY ON
Reliable Springs
ROUND AND FLAT WIRE SPRINGS · CLIPS · HOOKS · BENDS · LIGHT STAMPINGS

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DESIGN
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who is assured of maximum efficiency on every design because he specifies

**SCREW
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made
FASTER
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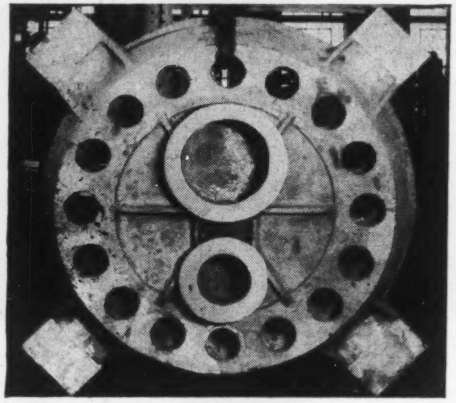
9,355 lb. BRONZE CASTING



. . . for lower Head of Nitrogen Generator

The above is just one of a number of large, intricate castings made by us for a well-known manufacturer,—and is typical of the work we have been doing for nearly 40 years. This casting is 7′11″ from flange to flange and 2′5″ high. Physical characteristics: 42,500 lbs. Tensile strength; 20,500 lbs. Yield point; 46.5% Elongation in 2″; 50.3% Reduction of area.

No doubt we can serve you in a similar bronze casting capacity . . . Send for literature and details,—and please use your Business Letterhead when writing us.

**AMERICAN MANGANESE BRONZE
COMPANY**

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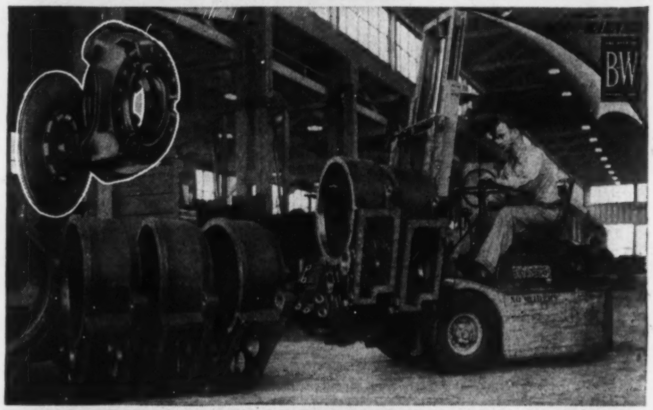
PITTSBURGH, PA.
38 Years' Experience

ROCKFORD



SPRING — LOADED CLUTCHES

- LIGHT PEDAL PRESSURE
- CUSHIONED ENGAGEMENT
- VIBRATION DAMPENING
- ACCURATE BALANCE
- DIRT EXCLUSION
- HEAT DISSIPATION *
- LIFETIME ADJUSTMENT

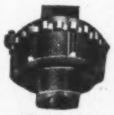
* Over a quarter century experience designing many types of clutches, for use in a wide variety of industries, has proved to ROCKFORD engineers the importance of liberating the heat that is generated within friction type clutches. For this reason, ROCKFORD CLUTCHES cover designs provide for ample ventilation. Other parts that help dissipate heat are designed accordingly.

SEND FOR THIS HANDY BULLETIN Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION BORG-WARNER
311 Catherine Street, Rockford, Illinois, U. S. A.

for safety and simplicity—

FLEXO JOINTS



STYLE "A"

STYLE "B"

The safety of a moving feed line is no greater than the safety of its flexible joints. That's why Flexo Joints are the standard wherever flexible or swing joints are required for steam, air, gas, water, oil or other fluids. Swivel full 360° with no flow restrictions.

FOUR SIMPLE PARTS

No small parts, no springs, no ground surfaces to wear. Fully enclosed from grit and dirt. In four styles—standard pipe sizes from ¼" to 3".

Send for Details and Specifications

FLEXO SUPPLY CO., Inc.

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where Fine Gears are produced

EFFICIENTLY, ECONOMICALLY!

If you use gears in the product you make, we believe it will pay you, as it has many others, to become acquainted with FAIRFIELD—the place where fine gears are produced to meet your specifications EFFICIENTLY, ECONOMICALLY! Fairfield's production facilities are unexcelled for making all kinds of high precision, automotive type gears such as are now finding wide application in all branches of industry: for machine tools . . . for agricultural implements . . . for construction machinery . . . for printing presses. No matter how special your requirements may be, Fairfield has the equipment and the "know how" to meet virtually any need. Ask for a copy of interesting, illustrated descriptive brochure.

FAIRFIELD
MANUFACTURING
COMPANY
311 S. Earl Ave.,
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For FINE GEARS

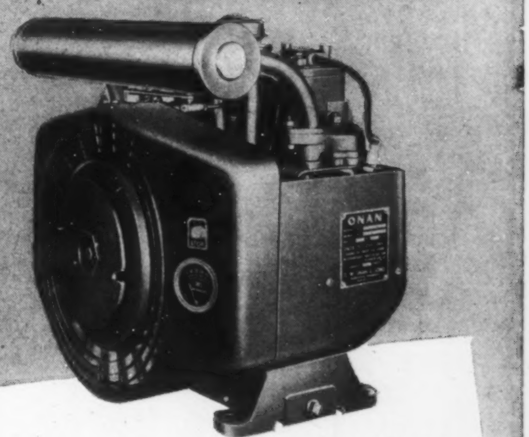
SMOOTH POWER

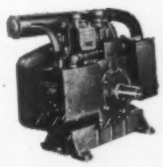
Two-Cylinder

The NEW ONAN

AIR-COOLED "CK" ENGINE

10 H. P. 4-CYCLE





Two-cylinder horizontal opposed design gives the new, heavy-duty CK engine unusual running smoothness. Short, rigid crankshaft . . . 2-inch diameter main and 1⅝-inch diameter rod bearings . . . pressure lubrication . . . axial-flow cooling fan . . . aluminum construction giving 4-to-1 cooling advantage over cast iron . . . weighs only 97 pounds and fits neatly into 15" x 19" x 18" space. Designed to solve engine power problems in industry, agriculture and other fields. Proven by thousands in use today . . . now in mass production . . . prompt delivery.

Also has: Built-in precision governor . . . downdraft concentric carburetor for wide-angle operation . . . oil bath air cleaner . . . fuel pump . . . oil pressure gauge . . . crankcase fumes exhausted to carburetor . . . hermetically sealed magneto ignition coil with easy-to-get-at breaker points, 2-qt. oil capacity.

ONAN ELECTRIC PLANTS—A.C.—350 to 35,000 watts in standard voltages and frequencies; D.C.—600 to 10,000 watts, 115 and 230 volts. Battery chargers—500 to 3,500 watts, 6 to 115 volts.

ONAN AIR-COOLED ENGINES—CK: 2-cylinder opposed, 10 h.p.; BH: 2-cylinder opposed, 5.5 h.p.; 1B: 1-cylinder, 2.5 h.p.

Electric Starting

Built-in electric push-button or automatic starting is optional; adds little to overall dimensions.

WRITE FOR COMPLETE SPECIFICATIONS

D. W. ONAN & SONS INC.

4339 Royalston Ave.
Minneapolis 5, Minn.

Onan PRODUCTS

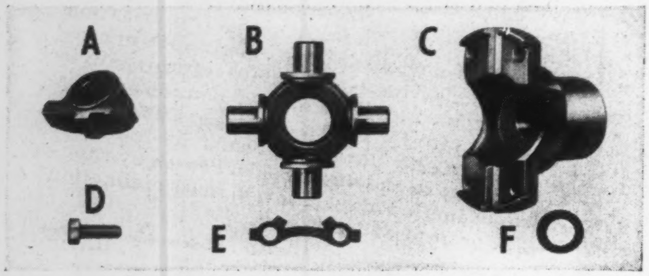
ONAN *4-Cycle* ENGINES

MECHANICS
Roller Bearing
UNIVERSAL JOINTS

A Size and Type For Every Use

BORG-WARNER
BW

Simple, strong, economical; Mechanics Type C Roller Bearing Universal Joints meet every industrial requirement. Unique construction and accurate machining promote inherent balance, smooth operation.



Type C has few parts. Four high grade roller bearing units — A, are ground to fit locating seats on two yokes — C. Strong integral keys carry the entire torque load. Cap screws — D, locked by plates — E, hold bearing units in the assembly. Roller bearings carry hardened cross — B, with cork seals — F.

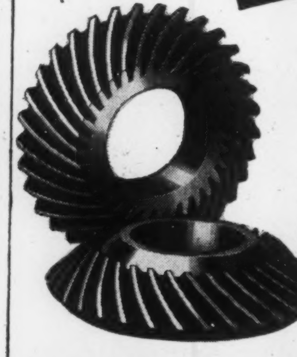
Cross and bearings of the type C joint can be removed readily by taking out the cap screws and separating the yokes slightly. No flange connection is required. Unusually easy to install and service.

MECHANICS Type C Roller Bearing UNIVERSAL JOINTS are available in sizes from 200 to 50,000 foot pounds torque, with a wide variety of end connections and shaft arrangements.

Don't worry over power transmission problems. Let our engineers suggest how MECHANICS Roller Bearing UNIVERSAL JOINT advantages will benefit your product. •

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2026 Harrison Ave., Rockford, Ill.

CINCINNATI . . .
Spiral Bevel Gears
HAVE MUCH TO OFFER



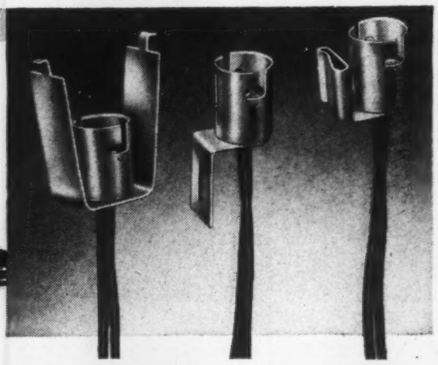
Maximum performance and dependability are two qualities that are absolutely essential in gears for any industrial purpose.

All Cincinnati Spiral Bevel Gears are cut, tested, matched, lapped and marked in individual sets . . . to insure correct bearing location on teeth.

For smooth, efficient operation at high speeds . . . specify Cincinnati Gears, *Good Gears Only!*

THE CINCINNATI GEAR COMPANY
"Gears . . . Good Gears Only"
Wooster Pike and Mariemont Ave. ★ Cincinnati 27, Ohio

**125 VOLT—
CANDELABRA**



NEW *UNDERWRITER'S APPROVED* BAYONET TYPE SOCKET ASSEMBLIES

Now you can get fine *Underwriter's Approved* candelabra Dial Light Socket Assemblies by DRAKE! The #900 series is designed for radio use, and the #A900 series for general use. Both are double contact, candelabra, bayonet Assemblies housing 115V household type lamps available from 5 to 25 watts. They are U.L. approved for 75W-125V service. Can also be used with 6V automotive lamps.

The bayonet type eliminates vibration-loosened lamps and requires less space than screw type. Can be supplied with any type mounting bracket. Lead-in wires from 2½" to 60". Made to traditional DRAKE standards of precision and rugged dependability. Check with our engineers on your requirements, *today!*

DRAKE

Socket and Jewel LIGHT ASSEMBLIES

DRAKE MANUFACTURING CO.
1713 W. HUBBARD ST. • CHICAGO 22

in SAO PAULO, BRAZIL

WISCONSIN HEAVY-DUTY *Air-Cooled* **ENGINE** renders "Assist" on Sewer Project

Whether operating a Carver Model KN2L pump, discharging water from an excavation for a city sewer installation in Sao Paulo, Brazil, or operating a concrete mixer in Kalamazoo, Mich., or handling any one of hundreds of outdoor jobs on a great variety of equipment . . . you can always depend on Wisconsin Heavy-Duty Air-Cooled Engines for on-the-job serviceability.

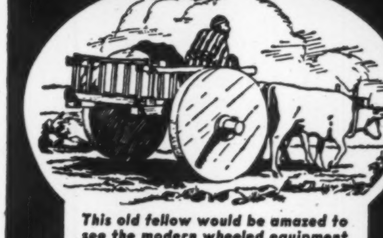
Compact in design, extremely light in weight, but designed and built for heavy-duty service in every detail . . . Wisconsin Engines are giving good accounts of themselves in all branches of industry, in many fields. These engines are built to fit the machine and the job . . . on any power application within a 2 to 30 hp. range, for all-weather service in any climate, anywhere.

Specify "Wisconsin Air-Cooled Engines" for *your* equipment.

Most H.P. per pound

WISCONSIN MOTOR
Corporation
MILWAUKEE 14, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

Early Man Wasn't
COST CONSCIOUS
•
NOW
it is
DIFFERENT



This old fellow would be amazed to see the modern wheeled equipment which has turned want into plenty.

Wheels that were adequate for the patient and plodding ancients would be utterly useless today. We demand action — efficiency — speeds — and uninterrupted production — in order that the many may enjoy the fruits of agriculture and industry at lowest possible costs. WHEELS "by French & Hecht" are soundly engineered to meet the exacting demands of TODAY. Mobile equipment is only as strong as the wheels upon which it is mounted. We know how to design, test and produce wheels capable of meeting the responsibilities entrusted to them. Specify WHEELS "by French & Hecht" with confidence.

Send Your Wheel Problems to Us

FRENCH & HECHT
DIVISION
KELSEY-HAYES WHEEL COMPANY
DAVENPORT, IOWA
WHEEL BUILDERS SINCE 1888

Best
Blue Devil SOCKET SCREW PRODUCTS

"Blue Devil" Socket Screw Products are known throughout industry as the finest quality obtainable. BEST because of their outstanding performance records and their 6 POINTS OF SUPERIORITY—the reasons why they are the favorite of modern industry:

1. **PRECISION MADE**—threads are an accurate class 3 fit.
2. **SPECIAL ALLOY STEEL** for toughness, durability.
3. **MADE BY SPECIALISTS** in socket screw manufacture.
4. **SCIENTIFICALLY HEAT TREATED** to insure a clean, uniform structure.
5. **QUALITY AT ITS BEST**—high manufacturing standards.
6. **WIDE SELECTION** of stock sizes and styles:

Socket Set Screws
Socket Head Cap Screws
Socket Head Stripper Bolts
Socket Screws—Dardelet Thread
Socket Screw Keys
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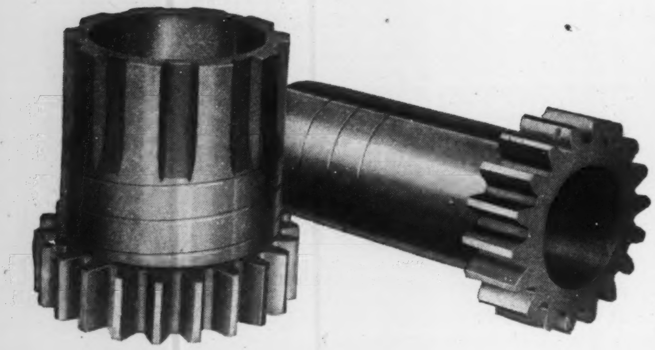
Blue Devil SOCKET SCREW PRODUCTS

SAFETY SOCKET SCREW CO.
4436 N. Knox Ave., Chicago, Ill.

Please send Free Catalog listing styles, sizes, prices and specifications of "Blue Devil" products.

Firm Name ....
Address ....
Attention .... Title ....



Custom gears made RIGHT *can slash your assembly costs!*

WHILE your product is still on the drawing board, investigate the many advantages of gears made especially for your requirements. Designing the gears to fit the product rather than the other way around will frequently make it possible to simplify and speed up assembly while providing better performance for the product.

Regardless of the quantity or type of gears you'll need, why not talk it over with us. Our experienced gear specialists will be pleased to make recommendations. THE ADAMS COMPANY, 1942 Tower St., Dubuque, Iowa.

The ADAMS Line

- Spur Gears
- Helical Gears
- Bevel and Miter Gears
- Worms and Worm Gears
- Internal Gears (spur and helical)
- Sprockets
- Ratchets
- Splined Shafts
- Racks
- Lead and Feed Screws
- Ground Tooth Gears (spur and helical)
- Shaved Tooth Gears (spur and helical)
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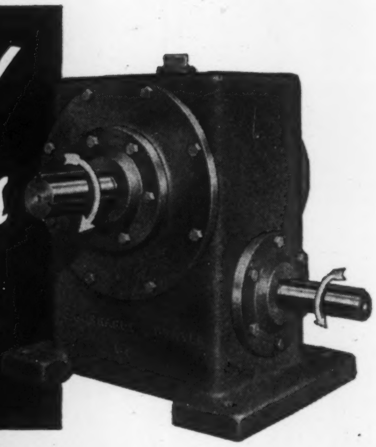
The ADAMS Compa
Dubuque, Iowa, U. S. A.
ESTABLISHED 1883

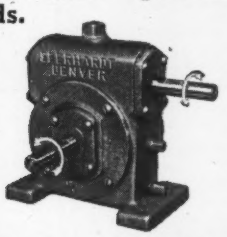
GEARS

FINE GEARS MADE TO YOUR SPECIFICATIONS

Speed Reducers FROM STOCK



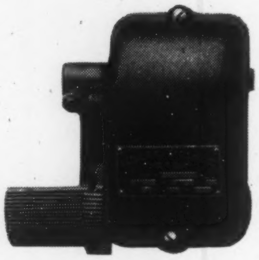
Manufactured in a practical range of sizes and reductions. We also build reducers to meet special needs.



CALL US LONG DISTANCE

Eberhardt-Denver Co.
GEARS AND SPEED REDUCERS
1416 West Colfax Ave., Denver 4, Colorado Phone TAbor 7134

Need New Foot Switches?



EUCLID
Foot-Operated
Master Switches
are used on
RUBBER MACHINERY
SPOT WELDERS
MACHINE TOOLS
and other industrial equipment

FEATURES

- Numerous Contact Arrangements
- Right or Left Foot Operation
- Controller Contact Fingers
- Latching or Non-latching
- Rugged Construction
- Low Maintenance

Ask for Bulletin 1021-MD

THE EUCLID ELECTRIC & MFG. CO.
1335 CHARDON RD. EUCLID 17, OHIO

Pipe-Coupling Tappers Employ NOPAK Cylinders *for* Fast, Positive Chucking

One of the features which contributes to the speed and capacity of Acme Pipe-Coupling Tappers is the self-centering air chucks which grip and position the couplings during the tapping operation.

These chucks are individually actuated by NOPAK Air Cylinders mounted behind each spindle. Downward and upward movement of the spindles operates the air valves which control the chucks . . . gripping and releasing the couplings as required, automatically.

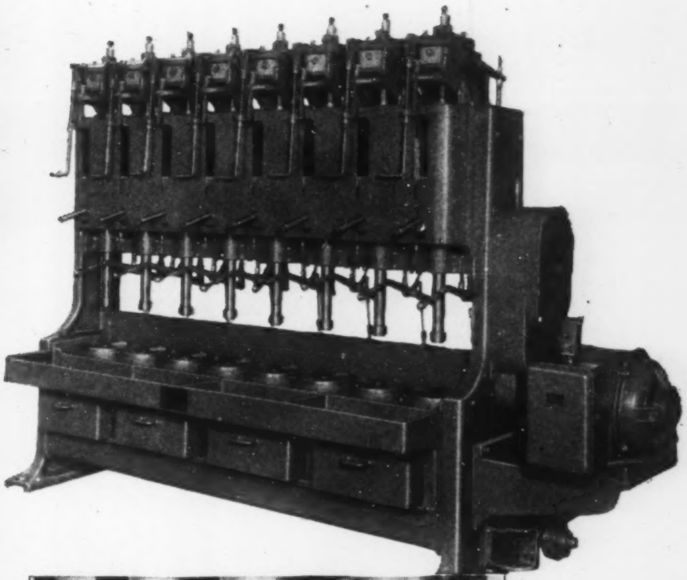
This is but one of many applications in which NOPAK Cylinders, Air or Hydraulic, supply the motive power for fast, positive machine movements. Write for Bulletin 92.

GALLAND-HENNING MFG. CO., 2752 S. 31st St., Milwaukee 7, Wis.

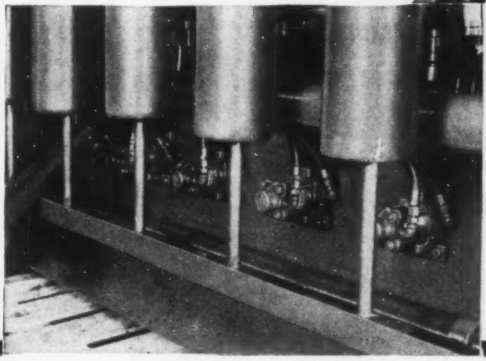
NOPAK

VALVES AND CYLINDERS

DESIGNED for AIR and HYDRAULIC SERVICE



ACME Model XT-C, 8-spindle, Pipe-Coupling Tapper employs 8 — 2" diameter, Model F NOPAK Air Cylinders.



Close-up shows how NOPAK Cylinders are mounted on back panel.

A 5233-½H

BELT LACING and FASTENERS for transmission and conveyor belts

"JUST A HAMMER TO APPLY IT"

ALLIGATOR

Trade Mark Reg. U. S. Pat. Office

STEEL BELT LACING

World famed in general service for strength and long life. A flexible steel-hinged joint, smooth on both sides. 12 sizes. Made in steel, "Monel Metal" and non-magnetic alloys. Long lengths supplied if needed. Bulletin A-60 gives complete details.

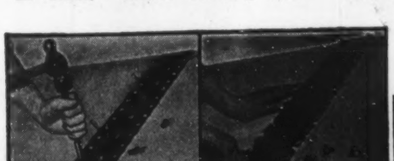
FLEXCO HD

BELT FASTENERS AND RIP PLATES

For conveyor and elevator belts of all thicknesses, makes a tight butt joint of great strength and durability. Compresses belt ends between toothed cupped plates. Templates and FLEXCO Clips speed application. 6 sizes. Made in steel, "Monel Metal", non-magnetic and abrasion resisting alloys.

By using Flexco HD Rip Plates, damaged conveyor belting can be returned to satisfactory service. The extra length gives a long grip on edges of rip or patch. Flexco Tools and Rip Plate Tool are used. For complete information ask for Bulletin F-100.

Sold by supply houses everywhere



"CONVEYOR BELTS EASILY FASTENED"

FLEXIBLE STEEL LACING CO.

4686 Lexington St.,
Chicago, Ill.

You're GUARDING Your REPUTATION When You Make WITTE Diesel Power Standard Equipment on Your Machines

WITTE

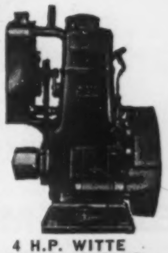
EST. 1870

Uncertain, inadequate powering of your machine as you well know would be extremely costly to you. Make rigorous tests and comparisons—your choice of WITTE Diesel powering will free you from power-problem worries. You'll know your customers will always find replacement parts readily available, for the WITTE Dealer organization is world-wide.

WITTE DIESEL ENGINES and DIESELECTRIC PLANTS

7.5 KVA WITTE DIESELECTRIC PLANT

Safe for operation in confined places—give off no poisonous fumes. Matching all-around efficiency with space-saving, WITTE Diesel Engines and Dieselectric Plants require little room or attention. *Full* Diesels, they start and operate on cheap, non-explosive Diesel fuel available everywhere. Vertical and horizontal sizes from 4 to 12 H.P. and from 3 to 10 KVA. Write for specifications and descriptive literature.

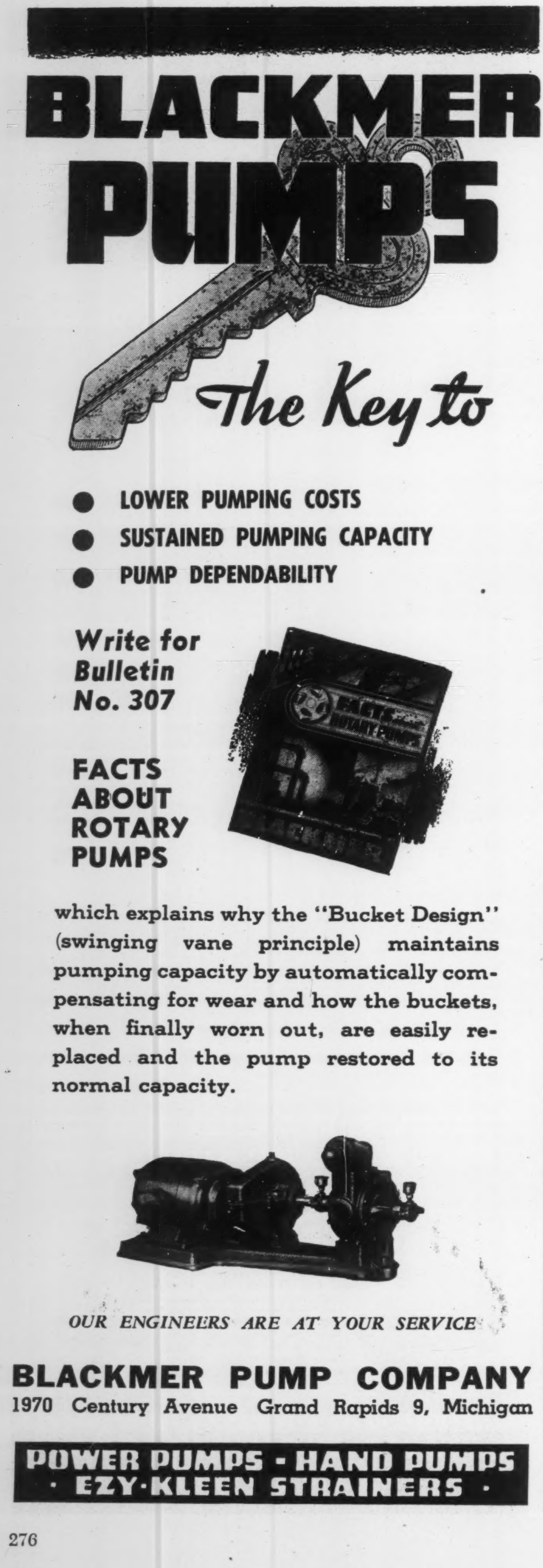


4 H.P. WITTE DIESEL ENGINE

WITTE ENGINE WORKS

DIVISION OF OIL WELL SUPPLY COMPANY
UNITED STATES STEEL CORPORATION SUBSIDIARY

AMERICA'S PIONEER BUILDER OF SMALL DIESELS KANSAS CITY 3, MO. U.S.A.



BLACKMER PUMPS

The Key to

- LOWER PUMPING COSTS
- SUSTAINED PUMPING CAPACITY
- PUMP DEPENDABILITY

Write for Bulletin No. 307

FACTS ABOUT ROTARY PUMPS

which explains why the "Bucket Design" (swinging vane principle) maintains pumping capacity by automatically compensating for wear and how the buckets, when finally worn out, are easily replaced and the pump restored to its normal capacity.

OUR ENGINEERS ARE AT YOUR SERVICE

BLACKMER PUMP COMPANY
1970 Century Avenue Grand Rapids 9, Michigan

POWER PUMPS - HAND PUMPS · EZY-KLEEN STRAINERS ·

MACHINE DESIGNERS *want . . .* **TRICO OILERS**

because TRICO Oilers modernize machines — improve their appearance — create new markets — reduce sales resistance and give "top-notch" dependable, automatic, visible lubrication. Here are just a few of the benefits TRICO Oilers offer . . .

- Complete Bearing Protection
- Added Machine Life
- Less Maintenance
- Streamlined Appearance
- Customer Satisfaction
- Easy Installation

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TRICO

TRICO FUSE MFG. CO., Milwaukee, Wis.
In Canada: IRVING SMITH LIMITED, Montreal

MARSHALLTOWN DIAL THERMOMETERS

NEW! Stainless Steel Bulb and Nut!

THE COMPLETE LINE

Now furnished in stainless steel bulb and nut, an accurate, compact, durable instrument for the indication of liquid or gas temperatures. They are available in a variety of temperature ranges—from minus 40° F. to plus 500° F. Actuation is positive, direct with full freedom—no gears or pinions. Available in sizes 2", 2½", 3½" and 4½".

WRITE TODAY FOR FULL DETAILS AND PRICES

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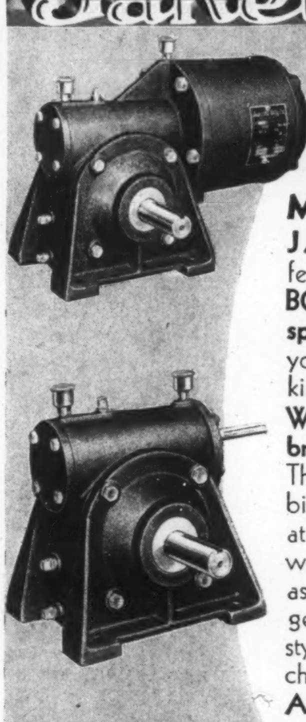


Janette

SPEED REDUCERS

ONE SOURCE . . .
Motorized or Motorless

JANETTE is one of the very few manufacturers who **build BOTH motorized and motorless speed reducers.** This enables you to standardize and buy both kinds from ONE source.

We build our own MOTORS, brakes, gear boxes and gears. This avoids divided responsibility for their satisfactory operation, which is not the case when a manufacturer buys and assembles motors, gear boxes or gears. We have 52 sizes and styles of SPEED REDUCERS to choose from.

ASK FOR CATALOG 22-27

1/30 to 7 1/2 H.P.
.08 to 447 R.P.M.

Janette Manufacturing Company
556 W. Monroe St. Chicago 6, Ill.

Millions of
Billings Wrenches
carry this
Trade Mark

If it's a FORGING See Billings

The simple, rugged forged parts are daily routine. Mixed in are the precision close tolerance jobs. They're all the same to Billings Forging Engineers—Production!

WRITE OUR FORGINGS DIV. Dept. SF-2

THE BILLINGS & SPENCER CO.
MAIN OFFICE AND PLANT
HARTFORD, CONN. U. S. A.

HOW TO SELECT *the Right* UNIVERSAL JOINT

CURTIS
CURTIS
STANDARD
BALL-TYPE

Universal joints perform various functions in a wide variety of applications — from heavy duty power transmission to high or low speed light duty installations. Selection of the *right* joint for the job is important.

Either the Curtis Standard — available in 14 sizes, from 3/8″ O.D. to 4″ O.D., single or double — or the *new* Curtis Ball-Type in 4 sizes, from 1/2″ O.D. to 1-1/4″ O.D., will enable you to specify the correct size and strength of joint to secure the most economical and trouble-free installation.

For heavy-duty jobs specify Curtis Standard Joints — made of alloy steel throughout with each part heat treated and ground for maximum strength, long life and accuracy.

For light-duty work specify Curtis Ball-Type Joints — with bronze center ball and steel forks with center pins of heat treated, centerless ground steel.

Select the RIGHT joint for your particular purpose from the data shown below —

				Breaking Loads	
Cat. No.	Type	O. D.	Overall Length	Static Torque in lbs.	Tensile Load Pounds
C-642	Std.	1/2″	2″	340	1000
CS-42	Ball	1/2″	2″	170	720
C-644	Std.	3/4″	2-11/16″	1300	2800
CS-44	Ball	3/4″	2-11/16″	650	2000
C-646	Std.	1″	3-3/8″	2500	5150
CS-46	Ball	1″	3-3/8″	1250	3600
C-648	Std.	1 1/4″	3-3/4″	5000	7200
CS-48	Ball	1 1/4″	3-3/4″	2500	4950

All Curtis Joints can be furnished with hubs machined to your specifications. Drawings should accompany inquiry if possible.

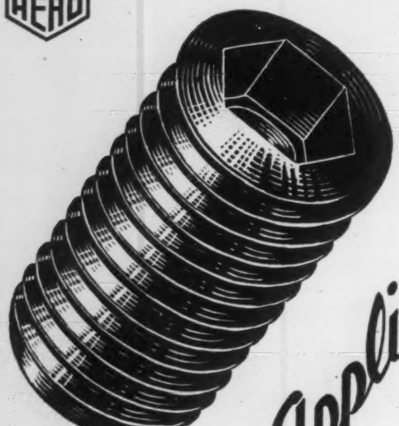
For complete engineering data and drafting templates write Dept. B

CURTIS UNIVERSAL JOINT CO. INC.
SPRINGFIELD MASS.

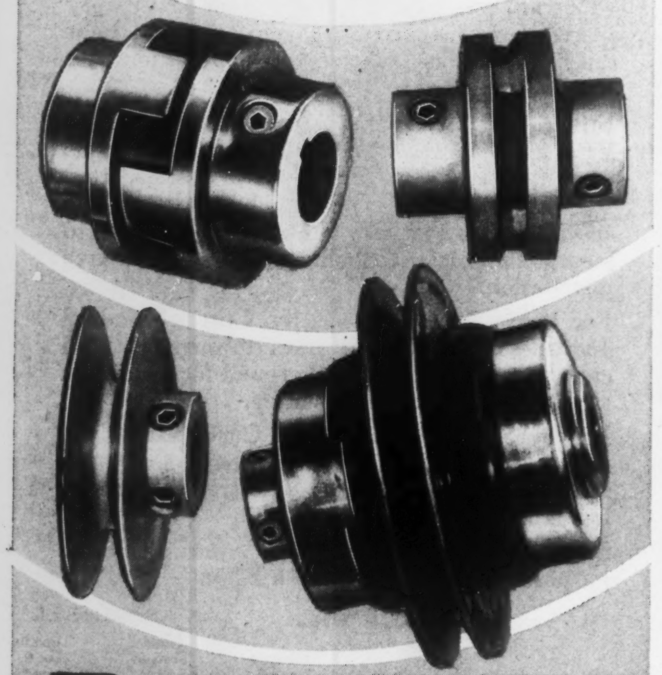
ALLEN

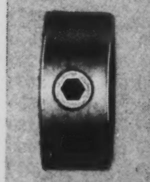
HEX-SOCKET SET SCREW

ALLEN HEAD



Applications

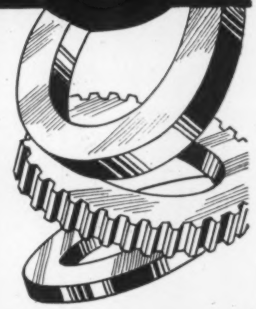




In collars, pulleys, couplings of all types, ALLEN Hex-socket Screws *grip* with never a slip. Formed and threaded by Allen-perfected processes, applied selectively to produce the strongest precision screw in a given size. High Class 3 fit standard; Class 4 on special order. Call your local Allen Distributor for samples or demonstration.

THE ALLEN MANUFACTURING COMPANY
HARTFORD 1, ★ **ALLEN** ★ CONNECTICUT, U.S.A.

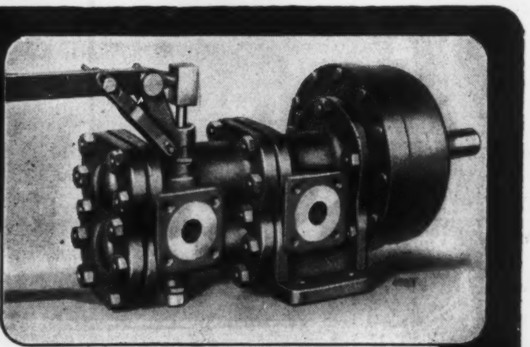
TOUGH to the last SLICE



because they're *Forged*

. . . and forged **right** by Smith-Armstrong in any of the S.A.E. alloys, high carbon, high chrome, high speed, nitralloy, stainless — or any machine steel giving you the required physicals. Let us quote on your next order.

Smith-Armstrong FORGE, INC.
1209 MARQUETTE ROAD CLEVELAND 14, OHIO



IMO reversible hydraulic motor permitting infinite speed variation in either direction

IMO POWER UNIT

The IMO principle embodied in a hydraulic motor makes an exceptionally simple, compact and reliable device for hydraulic power transmission.

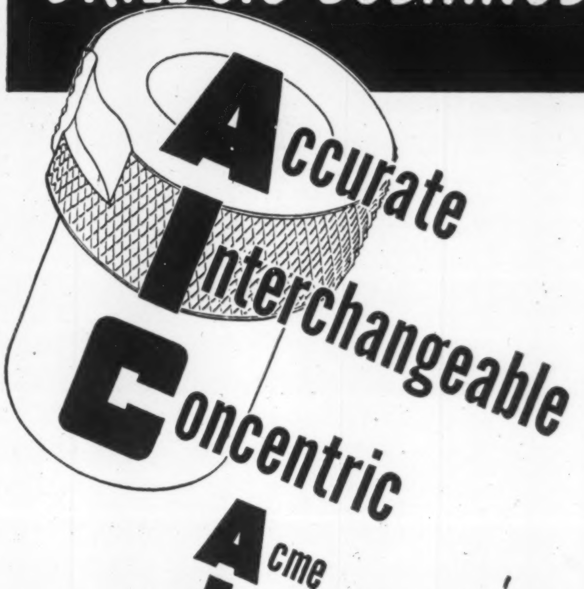
IMO hydraulic motors can be furnished for operation at varying speeds in either direction with corresponding variation in output.

For information send for catalog 1-130-D

IMO means I MOVE OIL

IMO PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

DRILL JIG BUSHINGS



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Interchangeable
Concentric

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Industrial
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211 N. LAFLIN STREET, CHICAGO 7, ILLINOIS

ARENS *Flexible*

REMOTE CONTROLS

Better Controls for Tomorrow's Designs

● If remote controls are a part of your present product or included in the design of your new product you can be assured of better performance with Arens Flexible or Rigid Remote Controls. Arens Controls are the result of 25 years experience in building controls to perform vital functions at maximum efficiency even under the most adverse operating conditions.

Arens also manufactures a complete line of control accessories including heads, end fittings, mounting clamps and the Arens Dura-Grom.

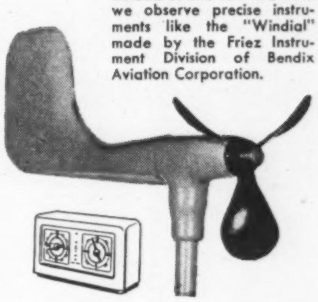
Write Today On Business Letterhead For Arens Catalog

ARENS CONTROLS, INC.
2257 S. Halsted Street, Chicago 8, Illinois

Silicone News

DC SILICONES

Instead of straws in the wind we observe precise instruments like the "Windial" made by the Friez Instrument Division of Bendix Aviation Corporation.



The "*Windial*"* points to permanent lubrication

Generations ago men could afford to measure the wind by watching straws blowing across the barnyard. They could afford to lubricate their wagon wheels with soap. We can't afford that kind of extravagance. Too much depends upon which way and how fast the wind is blowing. Too much depends upon keeping our precision instruments, our machine tools and the motors which drive them turning on anti-friction bearings.

Instead of soap or even the most carefully compounded petroleum greases we use Dow Corning Silicone Greases to get lasting lubrication under adverse conditions.

Take the "Windial" for example. It is set up high where the wind blows free. It stays outdoors year after year in the sun and rain, in the snow and ice. Temperatures may vary from −40° to 120°F. Speed varies from 0 to about 2000 r.p.m. The best of the organic greases wouldn't last long under such conditions.

That's why Bendix-Friez engineers tested and adopted DC 33 Silicone Grease for lubricating the annular ball bearings which take both radial and thrust loads from the propeller shaft of the "Windial."

That's another bit of evidence to support our claim that permanent lubrication means Dow Corning Silicone Oils and Greases. Within 5 years your customers will be demanding permanent lubrication. It's none too early to start working with the DC Silicone Greases described in data sheet No. B 7-4.

See our booth at the Machine Tool Show—Dodge Chicago Plant—September 17-26.

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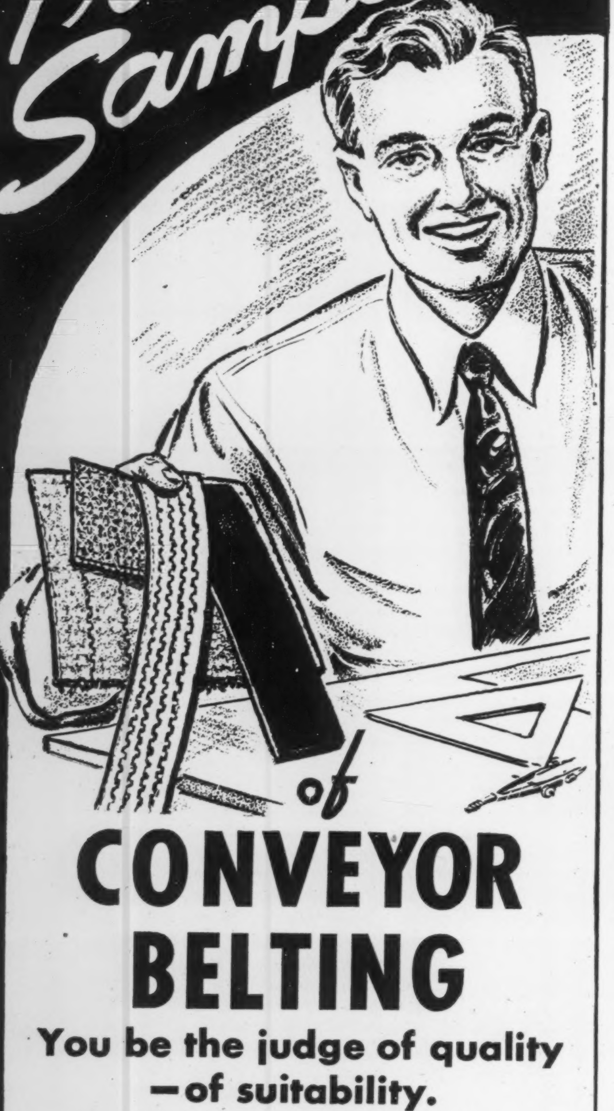

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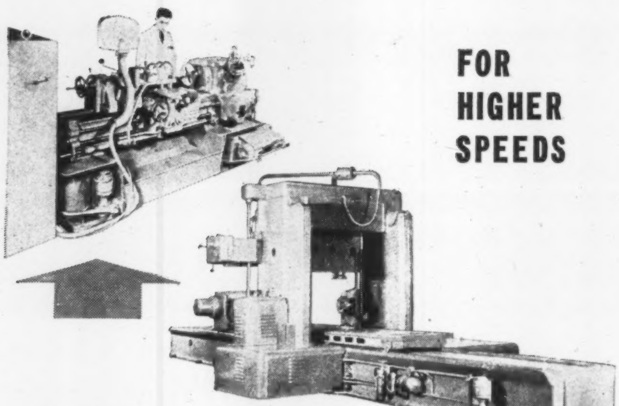

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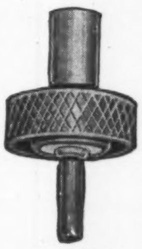

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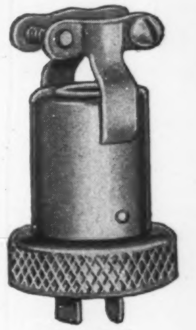

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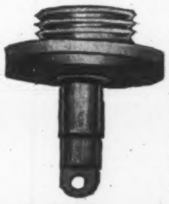

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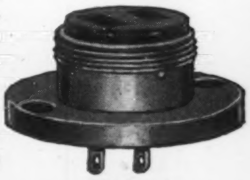

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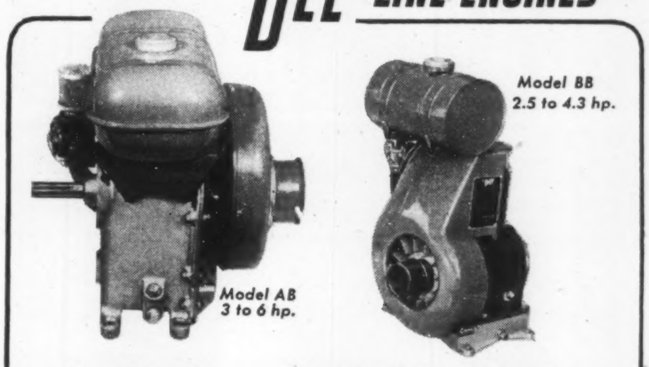

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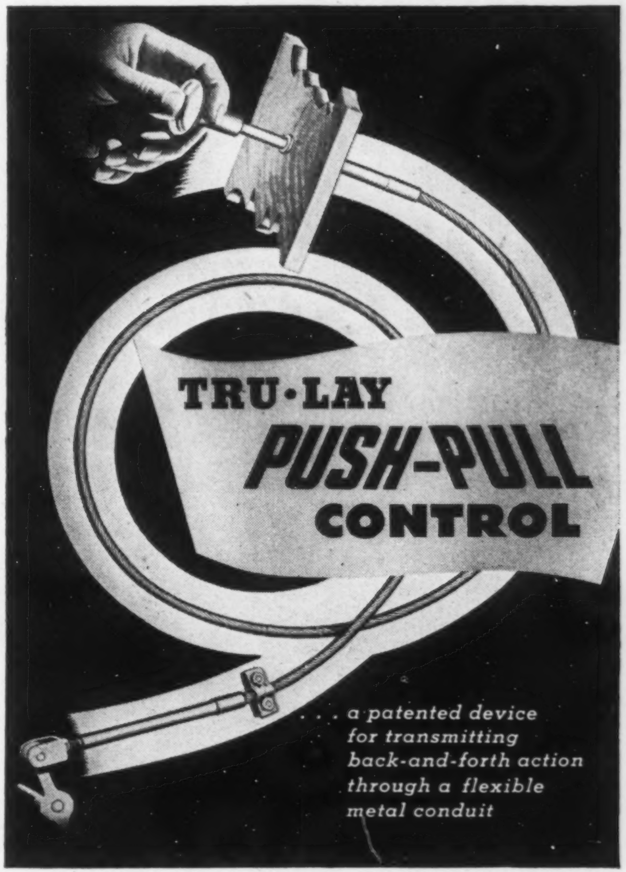

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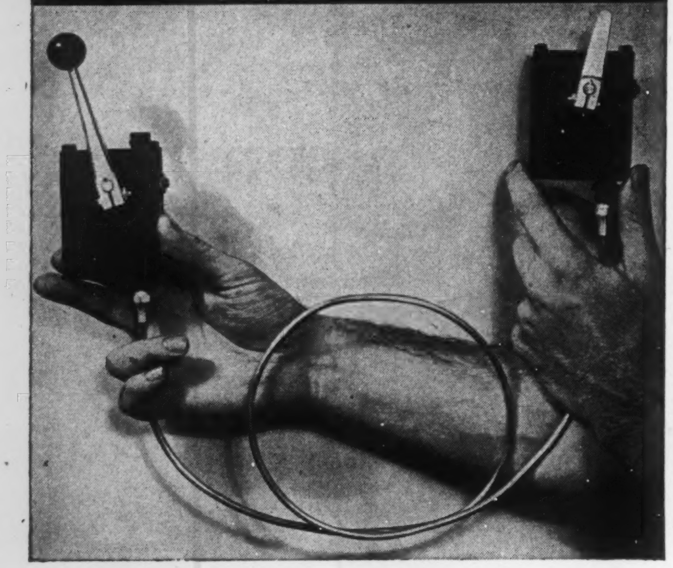

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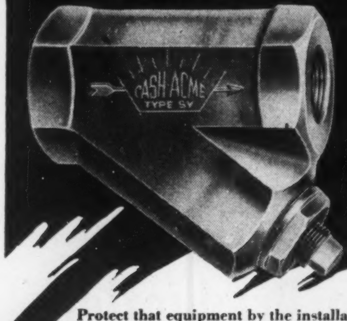

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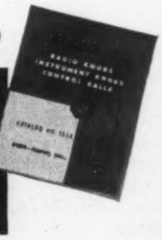

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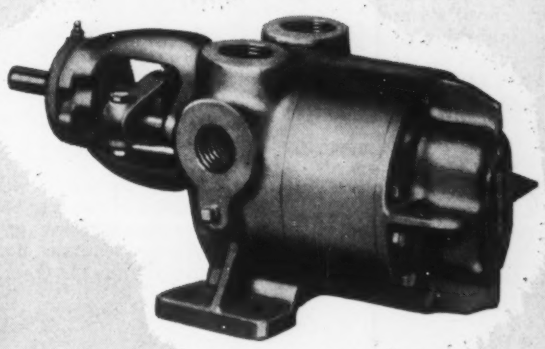

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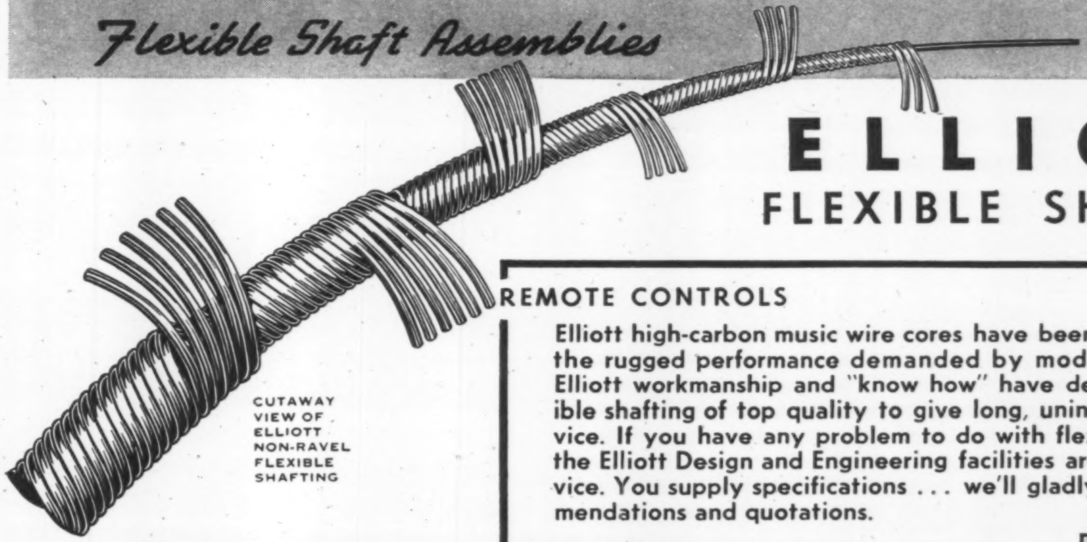

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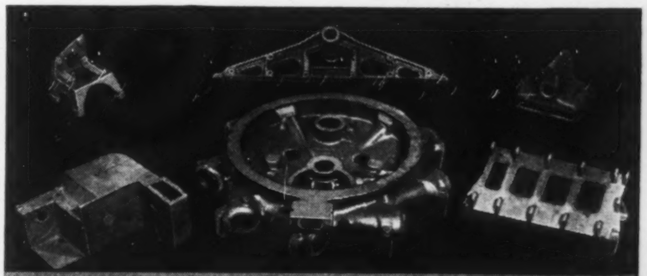

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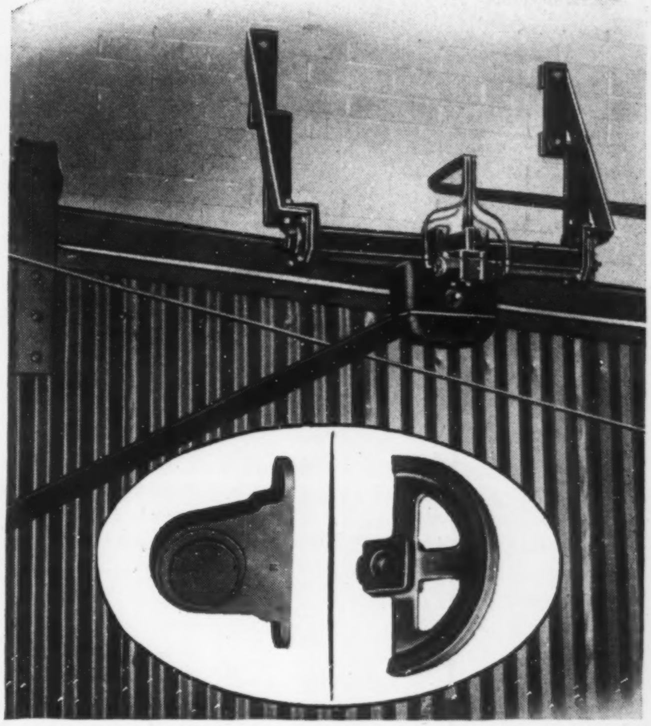

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The National Pneumatic Company originated and developed door operating and control equipment that is recognized as standard throughout the entire transit industry. Their doors are installed also in many factories, public buildings, arsenals, etc.

Our forgings have been chosen for the valve blocks and segment gears. The dies for these important parts—as for all National forgings—are so designed that the fibre-like flow line structure is concentrated at points of greatest shock and stress.

Forgings are being used for more and more products because they provide unparalleled toughness, tremendous fatigue resistance, and maximum strength.

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National forgings carry the trade mark "N"—your guarantee of Fine Quality Forgings.

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DROP FORGING DIVISION
NEWARK 5 **NEW JERSEY**

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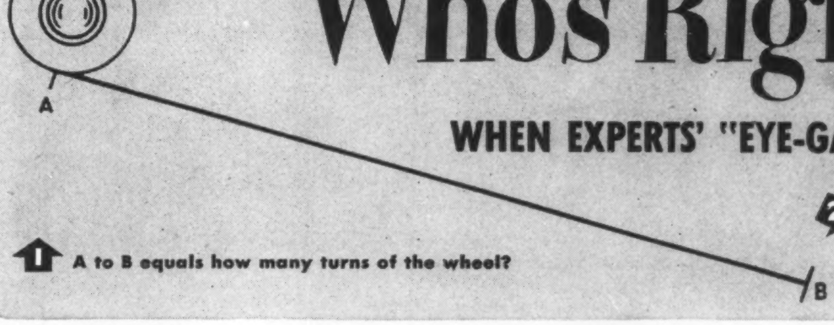
Who's Right . . .

WHEN EXPERTS' "EYE-GAUGING" DISAGREES?



① A to B equals how many turns of the wheel?

② What size is this Socket Screw?

Answers:
1. Two turns.
2. No question if it's Size-Marked!

● In everyday shop practice, many problems arise that require "eye-gauging". Identifying the correct size and pitch of an ordinary socket head cap screw is one example. In recent tests, this simple question stumped many good mechanics. On the job, if they guessed, they'd chance errors and delays. Good workmen don't guess—they "mike" or gauge the screw—but that, too, takes *time.*

Now, the SIZE-MARK on the head of every P-K Socket Head Cap Screw ends the need for guessing or gauging. Pick up a P-K Socket Head Cap Screw anywhere . . . no matter where it has strayed from the labeled box . . . you can see its size and pitch at a glance.

The SIZE-MARK is welcomed by assembly workers because it saves time. It helps the tool-crib men speed up sorting of mixed-up, left-over screws. It helps new workers learn screw sizes faster. It's a sales feature, too . . . maintenance men in the field can reassemble faster after servicing.

Plus GEAR GRIP*

Gear Grip on Size-Marked Socket Head Cap Screws is another aid to faster work . . . it saves highly-paid fingers from slipping, even when oily. *Only* P-K offers SIZE-MARK and GEAR GRIP.

SAMPLES FREE. Show advantages of P-K Size-Marked Gear Grip Socket Head Cap Screws in contrast with ordinary Socket Screws. Compare and judge for yourself. Write Parker-Kalon Corp., 200 Varick St., New York 14, New York.

You know you're right

IF IT'S P-K... IT'S SIZE-MARKED

P-K SOCKET SCREWS ARE
AVAILABLE FOR PROMPT DELIVERIES.
SEND FOR STOCK LIST NOW.

*U. S. Pat. No. 126,409

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PARKER-KALON *Cold-forged* SOCKET SCREWS

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MACHINE TOOL SHOW
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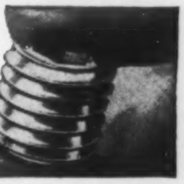
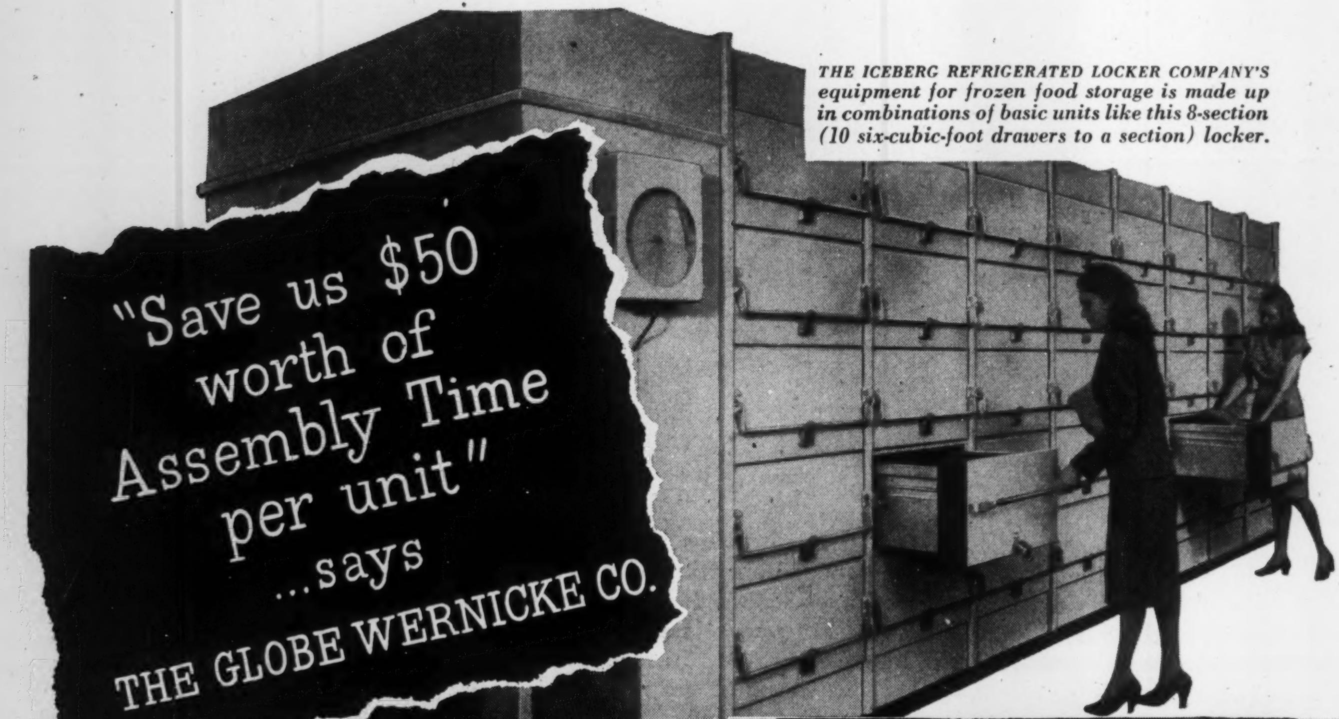
Another P-K First — *GROUND THREAD* Socket Set Screws



Smooth, mirror-bright, clean finished threads — centerless ground on hardened blanks. Faultless contour and lead, dependable Class 3 Fit. Free from imperfections common to ordinary cut thread set screws . . . a "shining example" of good workmanship. Get samples now . . . see and feel the difference!



THE ICEBERG REFRIGERATED LOCKER COMPANY'S equipment for frozen food storage is made up in combinations of basic units like this 8-section (10 six-cubic-foot drawers to a section) locker.

Summary of report by James O. Peck Co., independent investigators, of assembly savings made with Phillips Screws . . . another in the series of assembly studies at prominent plants.

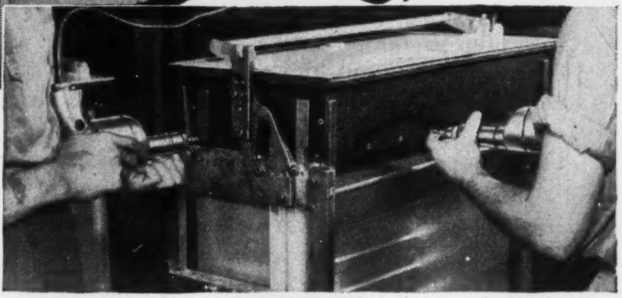
● "We manufacture these units for the Iceberg Refrigerated Locker Systems, Inc," explained the assembly head of The Globe Wernicke Co. "Our engineering department specified Phillips Screws throughout, and we're glad they did.

"Save us $50 worth of assembly time per unit. We can take full advantage of power drivers with Phillips Screws. No finder is needed and there's no fumbling such as we'd have with slotted screws. Since each unit requires thousands of screws, $50 is a conservative estimate of how much we save per unit by using Phillips Screws.

"Upside down or sideways . . . Makes no difference. Screws are driven with the unit in one position so that much of the driving is sideways or upside down. Difficult with slotted screws but very easy with Phillips Screws.

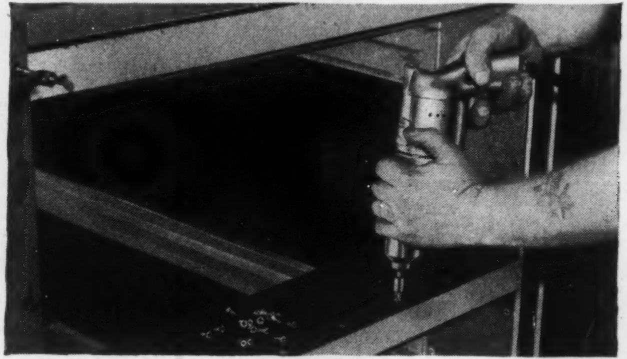
"No gouging or burring. Before we settled on Phillips, we tried out a lot of other type screws and found the driver would jump out and gouge the Masonite panels or burr the heads. Phillips Screws ended that, gave us better driving time with our power drivers."

Help yourself to money-saving ideas for your assembly operations. Write for the full report on The Globe Wernicke Co. and other assembly studies . . . covering metal, wood and plastic products. Use the coupon.



The complicated assembly of the drawer of the ICEBERG REFRIGERATED LOCKER . . . made without driver skids to injure work or hands, thanks to Phillips Screws.

Most of the thousands of Phillips Screws used in this assembly are Type "A", self-tapping, and are power driven up, down, and sideways.



PHILLIPS ***Recessed Head*** **SCREWS**

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

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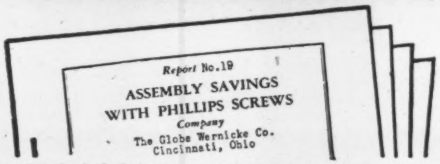
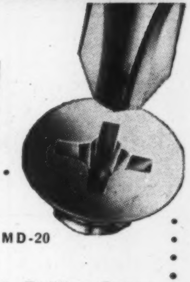


Report No.19
ASSEMBLY SAVINGS
WITH PHILLIPS SCREWS
Company
The Globe Wernicke Co.
Cincinnati, Ohio



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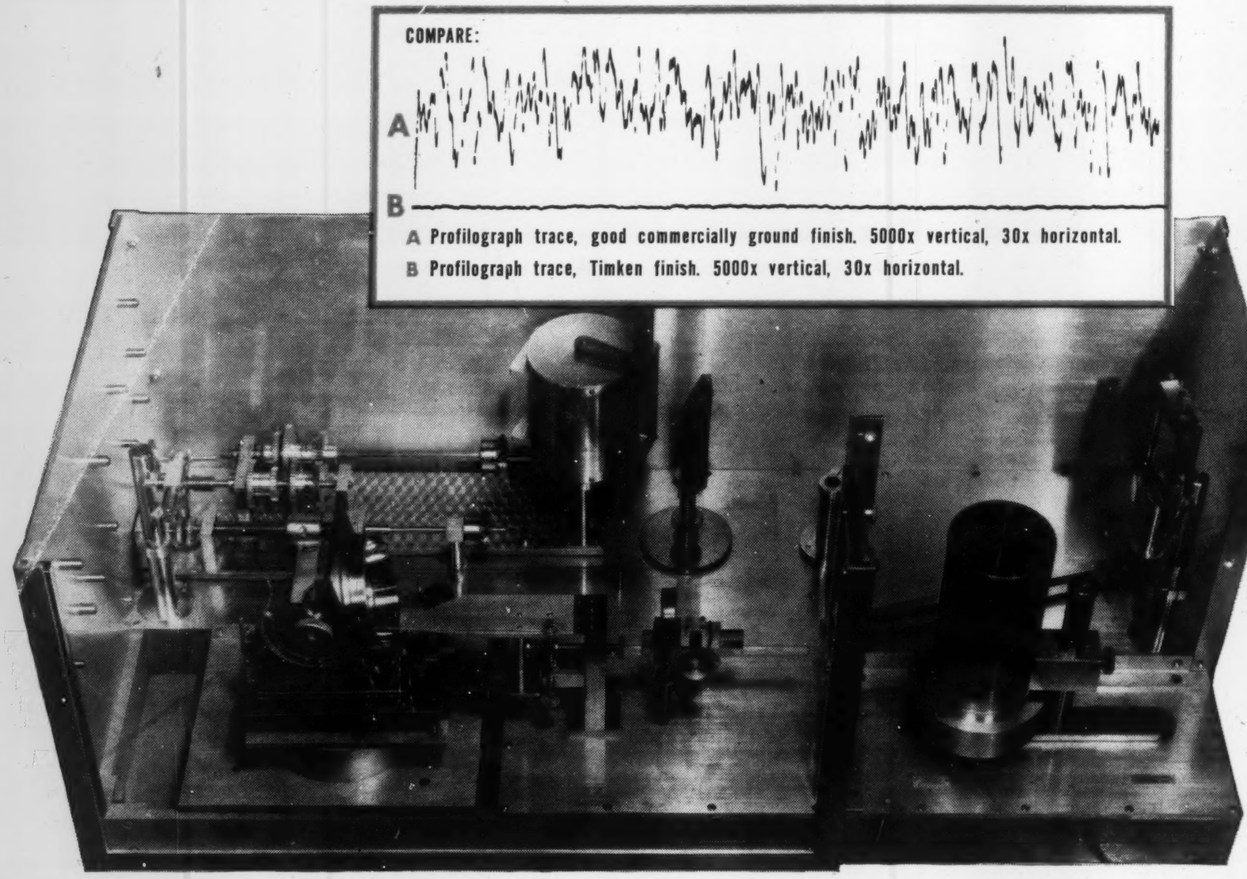
Timken bearings can make your product better . . . here's one of the reasons why:



A Profilograph trace, good commercially ground finish. 5000x vertical, 30x horizontal.
B Profilograph trace, Timken finish. 5000x vertical, 30x horizontal.

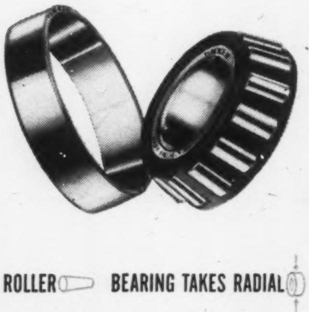
Answers the question—"How rough is smooth?"

ONE of the reasons Timken tapered roller bearings perform with such frictionless, wear-free ease is the amazingly smooth surface finish on the rolls and races—the finest known to modern bearing science.

Now, when you talk about finishes like this, you're talking about surface irregularities of only a few millionths of an inch—irregularities which are impossible to detect by any ordinary means. So, when Timken first began to develop this finish, one of the biggest obstacles was the absence of an accurate method of measuring the roughness of an apparently smooth surface.

The profilograph pictured above was the answer. Developed by Timken in 1928 and steadily improved since then, the profilograph determines surface irregularities to within one-millionth of an inch. Equipped with this measuring stick, Timken engineers were able to develop new finishing methods and machines, which have resulted in the microscopic surface accuracy of the Timken bearings you use today.

Every factor in the efficiency of a bearing is approached at Timken in this same scientific manner. For example, Timken makes its own steel to assure constant quality. And Timken is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels. No wonder you can always be sure of uniformly top quality and performance in the Timken bearings you use. The Timken Roller Bearing Company, Canton 6, Ohio.



TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

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